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ECONOMIC GEOGRAPHY

JULY

GEOGRAPHY OF MAST FEEDING
Earl B. Shaw

ESBJERG
William R. Mead

TUNG OIL PRODUCTION AND TRADE
George F. Deasy

GEOGRAPHY IN THE CENSUS BUREAU
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A DRY-FARM REGION IN UTAH
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SAN ANTONIO, TEXAS
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THE RÔLE OF DEATH VALLEY
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John H. Kemler

LAND USE IN THE BLUEGRASS BASINS
R. W. Johnson

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WAR

IN the long course of history the productive, creative, constructive phases of life and culture have been obliterated again and again by the cruel destruction and ruin of war. During the ages that man has struggled to lift himself up from squalor and ignorance, from selfishness and sordid brutishness, he has ever borne upon his shoulders the incubus of misunderstanding, and strife, and war to hold him back. His aspirations toward peace and plenty, freedom and security, have again and again fallen under the dreadful blight of war.

The scourge of war prevents man's escape from drudgery, from pain, from his baser, primitive self. War, and the dread of war, hang over the centuries as they pass, like a pall of smoke about a burning woodland, and obscure man's view of the goal toward which he struggles hopefully despite the toll in loss and pain war's tyranny wrests from him.

Like all men, geographers seek some way by which man may travel forward safely and happily without recourse to war. They know that within the content of their subject, within the limits of their field, lie many of the causes of war. They would search out and eradicate all such causes, that man might evermore be free from the horror and suffering, the rancor and hatred, that spring from war. It is the geographer's responsibility to spare no effort, to leave no field of opportunity unexplored, that might help destroy the scourge by removing its causes.

ECONOMIC GEOGRAPHY

VOL. 16 JULY, 1940 NO. 3

GEOGRAPHY OF MAST FEEDING

Earl B. Shaw

MAST feeding of hogs is old, dating far back to early times. In fact the ancestors of modern breeds of swine gained much of their livelihood through mast feeding, for they were creatures of the forest eating roots and grubs and nuts that fell from the trees. Even after the domestication of swine, mast feeding has continued for centuries. The husks which formed the ration for both swine and prodigal son of Biblical fame were not husks from maize as Bible readers of the Corn Belt might think, but fruit from the carob, the valuable bean-bearing tree of Mediterranean lands.

Histories tell us mast feeding was important in the Middle Ages when the value of most Central European forests was based primarily on the number of swine that might fatten from the falling acorns, beech nuts, and other tree crops of similar character. In medieval time woods were carefully surveyed to ascertain the number of hogs they would feed or fatten and were frequently designated as one-hog groves, ten-hog woodlands, hundred-hog woods, and other names signifying the carrying capacity of the forested land. Domesday book bears evidence of this by always recording the woods in their relation to swine, sometimes stating how many pigs forests were capable of feeding, but generally how many they yielded to the lord in range dues.

In our own United States the early pioneers raised much of their ham and bacon on the fruit of oak, beech, and chestnut groves, mast bearing trees of the forest that clothed nearly all the Appalachian country. And many barrels of salt pork which were sold to the fishing fleets or traded to the West Indies for sugar and rum were derived from swine fattened on the nuts of the eastern hardwoods.

Mast feeding is not nearly so significant in commercial or subsistence swine production as it was centuries ago. Corn, dairy by-products, potatoes, and other feeds produce pork of better quality and larger quantity. But swine fed on tree crops are still found the world over, still important in certain areas devoted to subsistence agriculture as well as in others stressing commercial agriculture, and still offer opportunity for profitable utilization of forest waste in many sections. For this reason it seems worth while to study the geography of mast feeding. Those students of animal geography who are interested in other phases of swine feeding, namely corn fed hogs, dairy by-product fed swine, and scavenger produced pigs may turn to *Economic Geography*, October 1936, "Swine Production in the

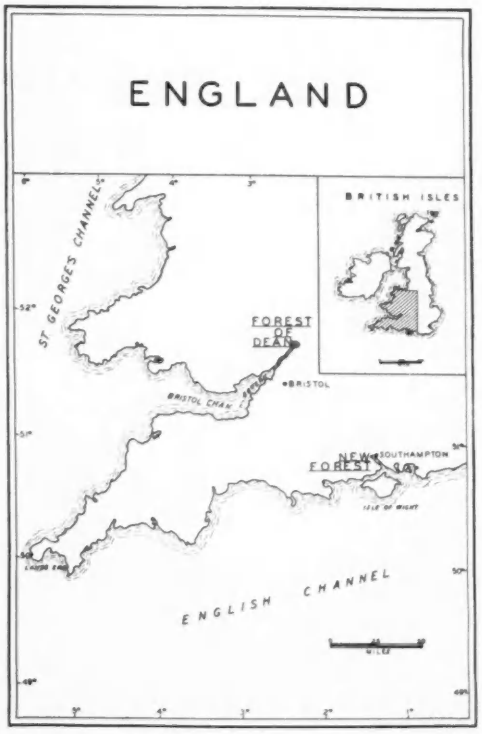

FIGURE 1.—Mast feeding is economically unimportant in England at present, but a few swine fatten on acorns from oaks in New Forest and the Forest of Dean.

Corn Belt of the United States," *Economic Geography*, January 1938, "Swine Industry of Denmark," and *Economic Geography*, October 1938, "Swine Industry of China," all written by the author.

EUROPEAN MAST FEEDING

The use of forests for swine feeding in the early days of English history was known as "pannage." The Encyclopedia Brittanica indicates that "pannage" is "a legal term for the feeding of swine in a wood or forest, hence use of a right or privilege to do this. The word is also used generally to apply to acorns, beech, and other mast upon which the swine fed." Baden-Powell state that "pannage is derived from a Middle-Latin word 'pannagium,' feeding swine on fallen acorns, said to be further derived from 'pastium,' feeding. The double 'n' marks some contraction as if it were 'pastinagium'; this is somewhat confirmed by the old French word 'pasnage,' payment to a landlord for the right of feeding swine." A study of the derivation and use of this word emphasizes the fact that words applicable to geographic practices will develop in local or national speech whenever the specific use for which the term is coined merits such coinage.

In medieval and pre-medieval time European cereal culture was little emphasized, improved grasses were yet to be significantly developed, and much of the land remained in virgin forest. As previously indicated swine are naturally creatures of the forest, well adapted to gaining a living from the woodland environment. They thrive in groves of mast bearing trees. Thus mast feeding or pannage was a normal and profitable adjustment to a European landscape covered with woods and characterized by very little crop agriculture.

England furnishes a good example of the importance of mast feeding, for the practice has continued there from early recorded history down to the present day. In Britain the woodlands were utilized for swine feeding as early as Celtic time (M. E. Seebohm, "Evolution of the English Farm," pp. 54–55). Seebohm quotes Strabo as writing in 30 A.D. that "swine live abroad" and says that the inhabitants of South England fed their hogs in the great forests of the Weald guarded by fierce dogs. During the Celtic period swine evidently lacked much of the domesticity displayed by hogs of the Corn Belt today. As evidence of their wildness, early Welsh laws provided that if pigs entered a house and scattered the fire about so as to burn the house, the owner of the swine should pay for the act.

Swine were very important to the Saxons and large herds were kept by owners of landed estates. Seebohm quotes a will in which two thousand swine were bequeathed to each of the testator's daughters as their sole legacy. During this period many hogs were bred on the farms and turned out in the public forests. As the manorial system developed, the lords of the manor seem to have annexed the public woods as their property and between

FIGURE 2.—Chestnut groves in the Ardeche Region of France. Although much of the annual crop is used in near-by candy factories, many chestnuts are gathered for swine feed.

August 29, the feast of St. John, and the New Year, allowed the villagers to run their pigs in the forest only on condition that they pay for the privilege.

Under Alfred a careful eye was kept on the benefit the pigs derived from their feeding in the woods and the contribution regulated accordingly; of those which had acquired three fingers thickness of fat, one-third were taken at the end of the season, of those of two fingers of fat, one-quarter and of those of a thumb thickness, one-fifth. Rental was also collected on the basis of a definite proportion of the animals regardless of gain. In Sussex, the customary payment amounted to one pig in every seven, while in parts of Cornwall, the assessment amounted to one pig in ten.

Between the time of the Norman conquest and the years of the Black Death, use of the woods for feeding swine was still important. In some areas swine were left in the forest under the charge of a swineherd during the regular mast feeding period of fall and early winter. In other sections swine were range fed throughout the year. In certain places the pigs were assembled daily from the village by the swineherd who drove them out either to waste land, grass land, or woods according to the season. Just as in Alfred's time, the villeins paid certain dues for their feeding and a very usual payment was one pig in ten. At Belchamp on St. Paul's estate all pigs that had been fed in the woods were driven to the hall of the manor to be taxed.

The mast feeding period seems to have decreased steadily from Celtic time on. During the early era, hogs were taken to the forest the last of August and remained there until the fifteenth of January. By the seventh century the Saxons had decreased the woodland feeding to the time between September first and the New Year; and at the time of the thirteenth century pigs were mast fed in October, November, and early December, the annual butchering usually coming in the later month.

Authorities seem to think that the reason for the shortened period is associated with a constant decrease of the forested area at the expense of cultivated lands. Probably this is the basic cause, but it must be remembered that population was slowly increasing and the number of hogs also. Finally as additional land was being cleared for cultivation, substitutes for mast were produced as well as food for man. All these factors were important in shortening the period of mast feeding.

Although overstocking was generally frowned upon, it may have been important in causing the abandonment of some forests. Usually a careful survey of the woods was made each season, for woodlands varied markedly in production of acorns and beech nuts from year to year. Generally speaking, a heavy mast crop was followed by one or several light yields. This marked fluctuation in yield can be ascribed to two main factors, the weather and the crop cycle. Good weather obviously favors heavy production, whereas unfavorable precipitation and temperature encourage minimum harvest. The crop cycle results from the fact that a bumper yield exhausts the trees and they are likely to produce less than average crops for a year or several years following. When their strength is renewed they will respond to favorable weather with another bumper crop.

Again, the quality of mast showed considerable variation not only with the year but also with the locality and age of the trees. Certain localities had more native beech trees, others were dominantly oak, and still others numbered many chestnuts within the forest. Moreover, there are marked differences among trees belonging to the same general type. For example the white oak yields a large sweet acorn every season whereas the black oak drops dark, bitter small fruit only once in two seasons. Finally, it is fairly obvious that regions characterized in the main by mature trees unaffected with disease will provide more mast than other sections dominated by either young or old vegetation.

Thus the allotment of forest area for each herd of swine varied considerably in acreage. In fact one is reminded of the great range in carrying capacity of the grazing lands of the United States. In the Great Basin region thirty to forty acres are needed to graze a steer, while in the Corn Belt one or two acres are needed to fatten the same animal.

Swineherds were cautioned to delay forest entrance in the fall until sufficient mast was falling for fattening purposes and to take the animals from the woodland as soon as all the year's nut harvest had been consumed. Too early an entrance or too late an exit not only caused damage to the trees but also resulted in a loss of flesh to the swine. Special care was taken to forestall damage to seedling forests.

Historians writing of the sixteenth and seventeenth centuries have little to say about mast feeding, but indicate that the woods were used as swine feeding grounds for five or six weeks annually. After this period the animals were kept in sties and fattened further

on dried peas or beans. In some places they were fed haws and crab apples from the hedges and these crops were stowed away by the poor people for winter's feeding. In Herefordshire swine were fed on elm leaves during the cold season.

A good idea of mast feeding in the eighteenth century may be gained from reading Reverend Gilpin's graphic account of forest practices in the New Forest region where he lived at that time.

"New Forest affords excellent feeding for hogs, which are driven in the autumn season into many parts of the woods, but especially among the oaks and beeches. It is among the rights of the forest-verderers to feed their hogs in the forest during the pasturage month, as it is called, which commences about the end of September, and lasts six weeks. For this privilege they pay a trifling acknowledgment to the Steward's Court at Lyndhurst. The word 'pannage' was the old term for the money thus collected.

"The swineherd, who generally takes charge of a drove of five or six hundred hogs at once, by feeding them in the first instance to the sound of a horn, can always collect them afterwards and prevent their straying away by means of the same rood music.

"Before taking the herd to the forest, the first step the swineherd takes is to investigate some close sheltered part of the forest, where there is a conveniency of water, and plenty of oak or beech mast, the former of which he prefers when he can have it in abundance. He fixes next on some spreading tree around the bole of which he wattles a slight circular fence of the dimensions he wants and covering it roughly with boughs and sods, he fills it plentifully with straw or fern. [Obviously with a herd of five or six hundred, several trees would have to be prepared in this manner and the swineherd would need helpers for such a job. Reverend Gilpin does not mention this fact but the writer has handled enough swine to know that several trees and several helpers would be necessary.]

"Having made this preparation, he collects his colony among the farmers with whom he commonly agrees for a shilling a head, and will get together perhaps a herd of five or six hundred hogs. Having driven them to their destined habitation, he gives them a plentiful supper of acorns and beech mast, which he had already provided, sounding his horn during the repast. He then turns them into the litter, where, after a long journey and a hearty meal, they sleep deliciously.

"The next morning he lets them look a little around them—shews them the pool or stream where they may occasionally drink—leaves them to pick up the offals of the last night's meal, and as evening draws on gives them another plentiful repast under the neighboring trees, which rain acorns upon them. He then sends them again to sleep.

"The following day he is perhaps at the pains of procuring them another meal, with music played as usual. He then leaves them a little more by themselves, having an eye, however, on them in the evening hours. But as their bellies are full, they seldom wander far from home, retiring commonly very orderly and early to bed.

"After this he throws his sty open and leaves them to cater for themselves; and from henceforth he has little trouble with them during the whole time of their migration. Now and then, in calm weather—when mast falls sparingly—[note the climatic relationship—author's comment] he calls them together, perhaps by the music of his horn, to a gratuitous meal, but in

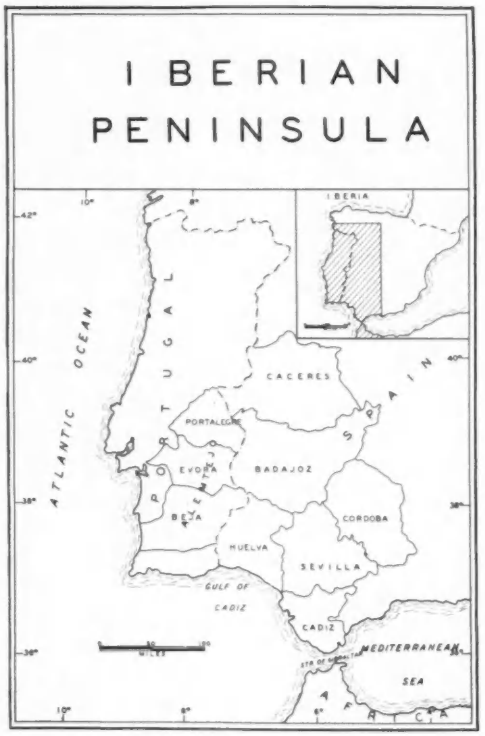

FIGURE 3.—Orientation map of the major mast feeding district in Iberia.

general they need little attention, returning regularly home at night, though they often wander in the day two and three miles from their sty. . . .

"Besides the hogs thus led out in the mast season to fatten, there are others, the property of forest-keepers, which spend the whole year in such societies. When the mast season is over, the indigenous forest hog depends chiefly for his livelihood on the roots of ferns, and he would find this food very nourishing if he could have it in abundance; but he is obliged to procure it by so laborious an operation that his meals are rarely accompanied with satiety. He continues, however, by great industry to obtain a tolerable subsistence throughout the winter, except in frosty weather when the ground resists his delving snout. Then he must perish if he do not in some degree experience his master's care. As spring advances, fresh grasses of different kinds add a variety to his bill of fare; and as summer comes on he finds juicy berries and grateful seeds, on which he lives plentifully till autumn returning brings with it the extreme of abundance." (Brown, J. C. "The Forests of England," Oliver and Boyd, Edinburgh, 1883, pp. 59–63.)

Historians describing English farming from the end of the 18th century on have little to say about mast feeding, but no doubt it continued with gradually decreasing importance down to the present period. Today Doctor Fawcett of London University writes as follows: "Round at least two of the ancient royal forests, the New Forest and the Forest of Dean (Figure 1), it is still usual for those neighboring freeholders who have rights of pasturage in the forest to pasture some swine there. These men are practically all small farmers or cottars; and few of them have more than from two or three to ten or twelve animals. I would say that mast feeding as a practice of economic importance is practically extinct."

The economic importance of this method of swine feeding has also declined in many other countries of Europe. In recent surveys on the swine industry of France, and that of Sweden (*Foreign Agriculture*, Vol. III, April 1939, U. S. Department of Agriculture), mast feeding is not mentioned. And yet in both countries the practice of pannage was extremely important during the Middle Ages. However, the writer knows from actual observation that mast feeding is practiced in France in certain of the more isolated districts. Five years ago, while doing field work in the Ardeche region, the author observed that nuts from some of the chestnut groves occupying the poorer hilly ground of that section were fed to hogs (Figure 2).

In the Balkan region the practice is still economically significant. It was extremely important just prior to the first World War. One writer states that it really influenced the incident that brought on the conflict. He reasons as follows: Serbia, a poverty stricken country, produced pigs, most of which were fed on mast, and the main market for these swine was Austria Hungary. Austrian counts, swine feeders themselves, placed a prohibitive tariff on Serbian pork. Without an adequate market Serbian farmers suffered serious economic depression and were willing followers of intense nationalism; and according to this same authority a rabid nationalism guided the hand of Gavrilo Princip when he fired the assassin's shot into Archduke Ferdinand.

Besides the woods of Old Serbia the forests of Rumania, Bulgaria, Jugo-Slavia, former Albania and especially the Bakony Forest of Hungary all produce acorns for pork production. Moreover, in the countries of the western Mediterranean, thousands of hogs are fattened on the fruit of the oak. A more detailed study of mast feeding in these countries may bring out geographic relationships more clearly.

MAST FEEDING IN PORTUGAL AND SPAIN

The Alemtejo province (Figure 3) of southern Portugal and the Seville consular district of southwestern Spain have been selected as examples of European areas where mast feeding is still important. Over one-fourth of the million or more swine raised in Portugal are grown near the three major centers of Alemtejo; these centers are Evora, Beja, and Portalegre, all of them situated where cork oak (Figure 4) and other species of oak are widespread. It is said that eighty per cent of the hogs produced in these political divisions are provided with acorns as a major element in their diet and that over half the swine of Portugal are raised on mast feed.

In the American consular district of Seville, which includes the area contiguous to the important towns of Badajoz, Seville, Cordoba, Huelva, Caceres and Cadiz approximately one-fourth of the five million or more swine found in Spain are raised. Like the pigs produced in the Alemtejo, which borders Badajoz, these Spanish hogs thrive on a dominant ration of acorns during at least a part of the year.

Both Alemtejo and Seville are mountainous districts with far more land suitable to tree crops than to cultivated agriculture. Both are regions of Mediterranean climate with conditions well below the optimum for best corn production or dairying. Consequently, if swine

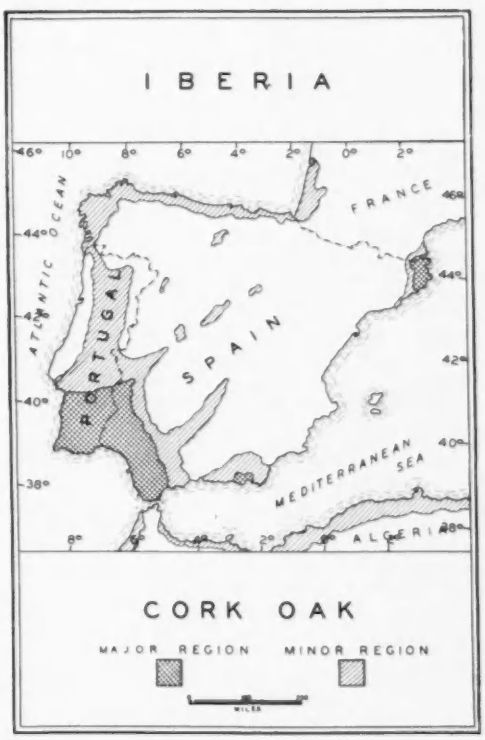

FIGURE 4.—Cork oak region of Iberia. Notice the correlation between the area of mast feeding (Figure 3) and the region of heaviest cork production. (After A. L. Faubel, *Cork and the American Cork Industry*, p. 11.)

culture is to be followed, mast feeding is the type most likely to yield profit from a limiting environment.

METHODS OF FEEDING

Several methods of feeding are followed in different sections of south-

FIGURE 5.—Pigs under the care of a swineherd in the cork oak forests of Iberia.

western Iberia, but the general season when the acorn item in the swine's diet predominates is common to all. The mast ripens during the months from October to February and swine roam the forests at this time. In the Alemtejo section, farmers let their hogs run wild through the cork oak regions during the *montanera*, or acorn feeding season, whereas in several portions of Seville the animals are placed under the care of swineherds handling about sixty animals each and equipped with long poles for knocking mast from the trees (Figure 5).

The reader may naturally ask what food is provided during the months from February to October. In the spring of the year swine are allowed to graze on grass and roots whose growth has been encouraged by the winter rains of the Mediterranean climate. Later on, after the small grain crops of barley and wheat have been harvested, hogs may be turned into the stubble fields to salvage the grain left after the primitive threshing is over. This manner and time of feeding reminds one of swine raising in China where scavenger hogs are fed wastes from the family table and those from the grain fields.

As previously stated not every year is a good mast year, for following an exceptionally large crop the trees are likely to "rest" for a twelve-month period before fruiting heavily again. Diseased trees may also influence the production of mast. In the Alemtejo district yield of cork oak may be restricted by attacks of a disease known as "Burgo." At such times the hogs are given acorns from other oak trees which are said to be less fattening than those of the cork variety. During the "lean" years of acorn production, the animals finish the season in comparatively poor flesh, and it is necessary to provide supplementary feeds to give them marketable weight and quality. Corn from the Portuguese colonies may be imported during these years of low acorn yield. Moreover, farmers who have no access to cork oak forests may feed hogs on colonial or domestic corn entirely, the latter being raised in northern Portugal where climatic conditions are more suitable for maize than in the south.

The cork oak acorns make a cheap and efficient hog feed. If the producer of swine owns the cork forest he may consider the acorns as a by-product of the cork bark industry; if he rents forest feeding privileges, rental charges are nominal and feed costs are kept at a minimum. Thus the farmer who has a cork forest or is able to rent one has considerable advantage over hog raisers obliged to fatten their animals on corn. Not only are costs lower, but the quality of the finished product is said to be better. The writer doubts this last statement in view of the soft pork research that has been going on in the United States. Some feeders claim that certain types of acorns do not develop

soft pork; but most all tests fail to substantiate this claim.

FARROWING

Farrowing may take place twice during the year and in most places this season occurs in January and in August. The pigs born in the first month are nearly a year old before they are turned into the forests whereas fall-farrowed pigs begin eating acorns at an early age. The latter may have two harvests before they are sold, as few swine reach the market before they are one to two years old. This is quite a contrast to the six to nine months marketing age of hogs from the United States Corn Belt.

Winters in regions of Mediterranean climate such as southwestern Iberia are mild and the shelter problem for farrowing sows and pigs is less serious than that encountered during the winter months in the higher latitude locations of the United States Corn Belt and the dairy by-product region of Denmark.

In some districts individual houses are allotted to farrowing sows, a practice similar to that of using McLean houses in the United States. Even as recently as a few years ago many sows in the Cadiz district were placed in crude conical huts made of straw and rushes. Large ranches, however, usually have more substantial breeding quarters.

BREEDS OF HOGS

The hogs of southwestern Spain are said to belong to the Iberic breed characterized by medium sized heads, strong short necks, backs slightly convex, and a sparse growth of bristles. The comparatively low latitude of the region probably accounts for the sparsity of hair and bristles. It may be remembered that swine of northern China and Manchoukuo produce a much heavier growth and better quality bristles than those of southern China; and it seems logical to believe that latitude may influence hair and bristle growth upon swine in Iberia just as it apparently does in China.

Several types of the Iberic hog may be noted. In the Badajoz district of the Seville consulate section, the breed known as the Extremena has two varieties, the Guadianesa, grown along the Guadiana river, and the Raya, grown along the Portuguese border. Both types are black in color with sparse hair and bristles, but the Raya is a smaller animal. The Portuguesa, common in Portugal, is reddish in color and almost hairless. Nearly all Iberian hogs are hardy animals with excellent foraging qualities and they fatten rapidly when being prepared for market. One writer in speaking of the foraging quality of Iberian swine says that they find food in pasturage so poor that it would be entirely insufficient for hogs raised in northwestern Europe. The much more arid Mediterranean climate produces less luxuriant grasses of all types than the West Coast Marine climate.

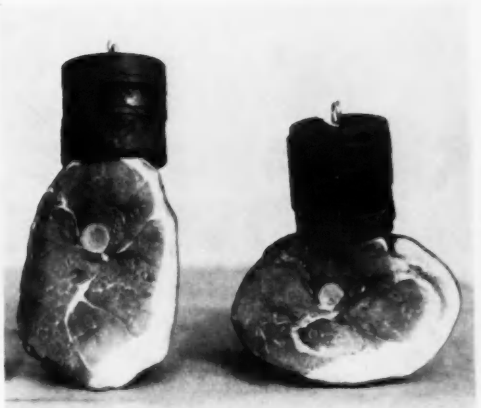

FIGURE 6.—Smoked hams from hard and soft carcasses. (Courtesy of U. S. Department of Agriculture.)

SUMMARY AND CONCLUSIONS

Both the Alemtejo and Seville sections are districts where mast feeding, generally declining throughout the world, is still important. Both regions are characterized by rugged topography and semi-arid climate, a combination of physical factors which favors tree crops but one which is not favorable to maize growing or dairying. Here hog raising becomes a by-product of the cork industry in contrast to the pig production of Denmark which is a by-product of dairying. Further contrast to Denmark may be seen in the extensive rather than intensive type of stock raising. In the latter, small farms, high priced land, and much labor are involved; in the former large farms, cheap land, and a minimum labor supply are needed. In both sections the type of swine culture is well adjusted to the physical environment. (The foregoing data on hog-raising in the Seville district are based on information supplied by the Junta Provincial de Ganaderos, Badajoz, Spain. That concerning the Alemtejo region is based on information supplied by Carl F. Deichman, American Consul General Lisbon, Portugal.)

MAST FEEDING IN THE UNITED STATES

Like mast feeding in Europe, the feeding of swine in the forest is an old industry in the United States. Unlike Europe, however, there was no opportunity for domestication of wild hogs here for the wild hog of Eurasia, from which domestic swine no doubt evolved, was not indigenous to America. Instead, domestic swine were shipped from that continent by the early explorers and settlers. The Spanish explorer, DeSoto, brought hogs into Florida in 1538, and a few years later other shipments reached more northerly sections of the Atlantic coast. Conditions were ideal for mast feeding in this new land. Much of what is now eastern United States was originally woodland and many rugged sections were covered with mast bearing trees such as oak, beech, and chestnut.

From histories of agriculture in the United States many statements concerning mast feeding, such as the following, may be found: "As soon as acorns, beech nuts, and other mast feed begin to fall, hogs are driven to the woods in large herds to feed on them" (from colonial records of Vermont); "Hogs are numerous and many are bred and kept by the settlers in the neighborhood of the woods and lowlands" (from colonial records of New York); "Of all domestic animals, hogs are the most numerous; they are kept by all the inhabitants, several of them feed a hundred and fifty or two hundred. These animals never leave the woods where they always find a sufficiency of food, especially in autumn and winter" (from colonial records of Kentucky); "In Virginia and Maryland it was not customary to feed cattle or swine but only to kill them fat out of the woods" (from early colonial records of Virginia and Maryland).

One of the best descriptions of mast feeding as practiced in pioneer time is taken from a letter written by Miss Claudie Cox, Riverside Farm, Fort Blackmore, Virginia, to the writer within the last few months. "The raising of hogs in pioneer days in the mountains of Virginia, Tennessee, and Kentucky was quite extensive and remunerative with a minimum amount of labor and expense. The virgin forest was composed of oak, chestnuts, and beeches, all of which bore an abundance of nuts known as mast. Here the hogs were left and allowed to multiply, fatten, and fertilize the land with their manure. The hogs were marked before

being turned out, each farmer having a mark of his own; this consisted of notches, holes, or slits in the ears. Some farmers brought their sows in near the buildings before farrowing time, feeding them there until the pigs were large enough to follow their mothers through the forest. The above method was followed by most farmers on average sized farms.

"Another method involved large sections of mountain land unfenced and practically free for all who cared to claim the privilege of herding their hogs on the mast. But the hogs could not be left without a herder. This practice resembles the sheep herding in the West where thousands of sheep are pastured on far flung grazing lands. I saw a large drove of hogs feeding on chestnuts in the mountains about twenty-five years ago.

"In both large range and small woodland mast feeding the hogs were driven in from the feeding grounds when fat and started to market on foot. Sometimes they were driven two or three hundred miles. Our market from the extreme southwest part of Virginia was Petersburg. Sometimes prosperous farmers or stock men brought them into market in a large drove after purchasing several small bunches; on other occasions hogs were marketed coöperatively.

"Recently a blight has killed all our chestnut trees, the large oaks have been cut and milled, and there are no more large droves of hogs in our mountains. The government has stocked them with deer; exit hogs."

These items, supplemented with scores of other similar proofs, show the historic importance of raising hogs with mast, an importance which has declined significantly since the close of the Civil War. Since then the great corn lands of the Middle West have been producing

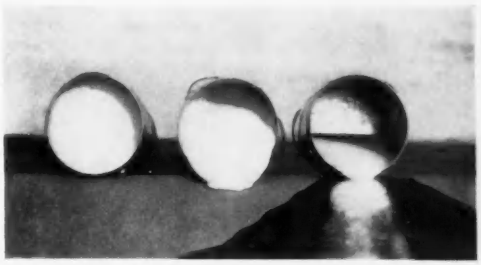

FIGURE 7.—Lard from hard and soft carcasses. (Courtesy of U. S. Department of Agriculture.)

enormous amounts of hams and bacon, and better pork from corn fed animals than the soft pork obtained from mast fed hogs of the eastern hardwood region (Figures 6 and 7). As suggested by Miss Cox, lumbering and increased settlement throughout the hardwood forest area have also decreased the relative importance of mast fed swine. Thousands of oak, hickory, chestnut, and beech have been fed to saw mills, and stump lands have been grubbed by purchasers of small farms in the cut-over country. Disease also has had its part in limiting mast production just as it has in changing the producing areas of many world commodities. The chestnut blight mentioned by Miss Cox has extended its curse far and wide, and with the passing of our chestnut forests one of the best mast feeds has been almost eliminated. The state and federal governments have purchased definite areas of mountainous lands for various purposes and have thus withdrawn large sections from mast feeding.

With the development of good roads and the use of trucks, another handicap to mast feeding has appeared. Stealing swine has become no uncommon occurrence; it is comparatively easy to shoot range swine and throw them into a truck and drive quickly out of the immediate locality—much easier than stealing coal from the closed coal mines,

a practice followed in these same Appalachian mountains in recent years.

In spite of all these handicaps, mast feeding is still practiced throughout the United States. Before undertaking the study of present day importance, the author wrote for information to Mr. J. H. Zellar, Senior Animal Husbandman in charge of Swine Investigations, United States Department of Agriculture, Washington, D. C. Mr. Zellar replied that no published information was available on the subject and advised the writer to correspond with the directors of extension bureaus from the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Questionnaires were sent to these directors and the maps and discussion following are based largely upon information received in reply (Figure 8).

Two major types of mast feeding may be distinguished although several hybrid methods might well be added. With the first plan, mast provides practically the entire ration for the hogs and the animals remain in the forest until driven off to market or killed for home consumption. In the second type mast feeding in the forest occupies only a portion of the fattening period. An examination of each type follows.

Louisiana reports several areas where mast feeding practices fall into class number one. C. L. Hill, Extension Animal Husbandman from the University of Louisiana indicates the location of mast feeding and describes conditions in the woodlands:

"We have a number of areas in this state where all hogs are placed in the woods and allowed to reproduce and make a living the best they can. These include cut-over pine lands in the southeast and southwest parts of the state where a few low sections are covered with hardwood trees; the region around Bayou Mason which enters the Tensas River in the edge of Concordia Parish, the lands around Boeuf River Swamp which enters the Ouachita River, the swampy area of the Ouachita River, the lowlands for some distance along the Red River, a section along the Mississippi River north of East Baton Rouge and West Baton Rouge Parishes, and the lowland along the Atchafalaya River from where it leaves the Mississippi River to the north edge of St. Martin Parish. The greatest concentration of wood hogs is in Concordia, Catahoula, Caldwell, and Franklin Parishes where there is a large area of hardwood timber which produces high yields of mast.

"About the only care given the swine is the destroying of predatory animals, principally the wolf, and riding through the woods to keep thieves from stealing. Under this system the number of pigs raised per sow is usually one or two per litter. They are usually of extremely low quality and border in the majority of cases on what is known as razor backs. The hogs are allowed to run until a year of heavy mast, at which time the bulk of the animals will carry sufficient flesh to be sold as a low type of killer hog, the majority being unfit to be used as feeder hogs."

Another example of this type of mast feeding is described by E. M. Regenbrecht, Extension Animal Husbandman, College Station Texas:

"The eastern half of our state has numerous areas where native oak timber is in abundance and practically all the native oak growing in this state produces acorns. The yield is very irregular but all the acorns ripen in the fall of the year. Some years we have a very heavy yield and other years the crop is light. All of our mast producing areas are poor grain sections; conse-

quently hog production in such areas is largely dependent upon the mast crop. Farmers run their hogs on the range and as a rule most of the swine remain in the woods for twelve months in the year. In years that a heavy mast crop develops the woods hogs are all fat and within four months after the acorns begin to ripen most of the sows farrow pigs. In a heavy acorn year the pig crop is always good. These range pigs stay in the woods and live on those feeds that they can find during the remainder of the year. They are usually quite thin and make a very slow growth until the fall season of the year. If the acorn crop the next year is good they fatten rapidly and the farmers have lots of fat hogs for sale. The pork produced from mast is classed as soft pork and mast fed hogs sell at a discount of from one dollar to two dollars per hundred weight. In spite of the discount the enterprise is very profitable in years of heavy acorn fall, for the farmer spends practically nothing in producing such swine. The pork produced from this area in lean mast years is very little. The farmers just keep the hogs and allow them to run in the woods. The death rate in these years is quite high, of course, and the pig crop is small.

FIGURE 8.—Mast feeding lands in the United States. The map is based upon information received from swine specialists of extension bureaus in the various states reporting mast fed hogs. By comparing this map with detailed physical maps of the United States some striking relationships may be noted. In North Carolina most mast feeding takes place in the Blue Ridge region of the western part and in the coastal swamps of the southeast. A glance at West Virginia, Kentucky, and Tennessee will show that the rugged Cumberland Plateau is the center of mast fed swine production in these states. In Virginia mast feeding takes place not only in this plateau but also in the Allegheny mountains and Dismal swamp. In Arkansas the Boston and Ouachita mountains provide feeding grounds for many swine. South Carolina shows mast feeding to be most important in the mountains of the northwest and along the coastal and river swamps. Detailed maps of Missouri, shown in this article, bring out striking relationships among physiography, natural vegetation, and mast feeding. Relationships in other states may also be noted.

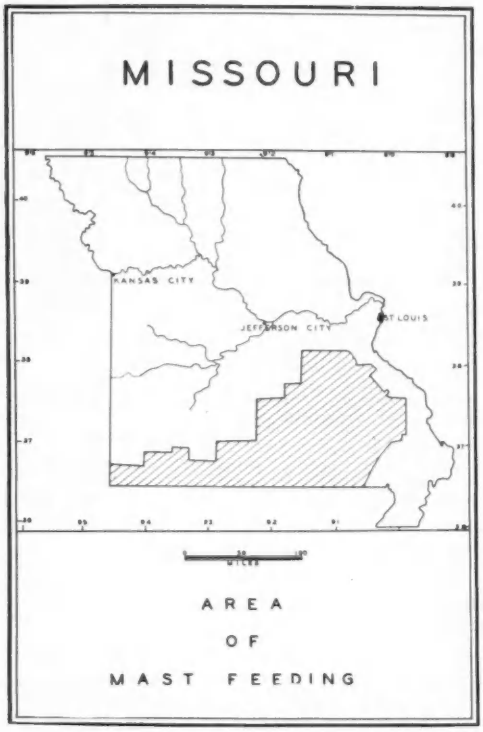

FIGURE 9.—Mast feeding section of Missouri. Notice the close correlation between mast feeding and the rugged Ozark Plateau and the area of mast bearing forests (Figures 10 and 11).

Probably two hundred and fifty thousand hogs in this state are produced annually in the mast growing sections." (If this estimate is correct, mast fed hogs comprise approximately one-sixth of the hogs of Texas, the total being 1,542,000 in 1938.)

Both examples of type number one show excellent adjustments to environment. Land which is unfit for cereal production may be used for swine culture; of little value for other purposes, large areas of mast bearing forests are well suited to this extensive type of industry. Requiring little attention mast fed hogs are well adapted to the sparse population characteristic of the woodlands. The industry, however, suffers from several handicaps. Inconsistent yields of mast influence the number of pigs raised, the number marketed, their weight and condition at marketing time, and death loss among the animals. With no fattening ration such as corn to harden the pork after mast feeding, the carcasses are penalized at the market by a price discount. Then too, the forest which is the natural home for the wild hog is also ideal for animals which prey upon him. Furthermore, isolation makes stealing hogs easy.

Farmers of the rugged forested counties of southeastern Missouri (Figure 9) furnish an excellent example of the second type of mast feeding. Here the feeding grounds roughly coincide with what is known as the Ozark Mountain and Plateau Section (Figure 10), a dome shaped highland region distinguished from the remainder of the state by greater elevation and dissection. Three-fourths of the area may be classed as forest and cut-over land, most of which was originally covered with black oak, white oak and hickory (Figure 11). Not over one-tenth of the ground is tilled and less than that should be cultivated.

These rough, timbered, well watered lands are well adapted to mast feeding, and it has been characteristic of the hill lands since early time. The first settlers in the region, who came largely from the mountainous parts of Kentucky and Tennessee, were not seeking a potentially great farming country. They belonged to a hunter-woodcutter-farmer class, who preferred a simple self-sufficient type of living. Many similarities to the early self-sufficient economy still exist.

Here approximately 275,000 swine or one-tenth of the 1938 number for Missouri may be found. In the river valleys corn may be produced and some animals receive a hardening in the final feeding period. The writer well remembers a large shipment of mast fed hogs from southern Missouri which he and

his brother purchased and finished off on corn in Central Iowa. The shipment comprised about a thousand head, bought during a lean mast year. Although their thinness and ranginess suggested lean feeding and razor back characteristics, their whole appearance changed significantly after three months of full feed on corn. By this method of finishing out on corn, the carcass hardened, the animals put on considerable fat, and there was no dock in price at the markets. Although not a significant industry, hogs are still shipped from this region into the Corn Belt for fattening.

Such a practice reminds one of grazing cattle in the Great Plains and fattening them in the Corn Belt, of grazing steers in the Campos region of Brazil and fattening them in the Sao Paulo region, or of grazing sheep in the high mountain pastures of the West during the summer and fattening them on the grain and hay, produced in the valleys below, during the winter. In each case there is a tie-up between a range land and a land of crop agriculture, between an extensive and a more intensive industry, between a region of low priced land and a region of higher priced land, between feeding practices involving small amounts of labor and care and practices requiring much more attention. Farmers near many sections of forest use the second type of mast feeding.

In the southeastern part of Virginia, the Dismal swamp area, the animals are turned out on the forest range in spring and remain there until late in fall. After harvesting the crop of nuts which are available at that time they are rounded up and driven home where they are fed out on corn, peanuts, and soybeans.

Finally the second type is found in Mississippi. E. H. White states, "Although range mast feeding, type number one, is practiced in a few isolated areas, many practical hog producers use available mast in the fall with spring-farrowed shotes. These hog breeders do not depend on mast as a major feed, but utilize it frequently when available, generally under fence. Pigs on mast are usually fed supplementary feeds. Mast is utilized to greatest extent in river and creek bottom areas."

A third classification might be suggested by some authorities, yet the practice, while common in parts of Europe, is of little significance in the United States. This method of feeding involves the collection and sale of mast for fattening purposes. G. W. Carver, Director of Agricultural Research, Tuskegee Institute, Alabama, writes, "The feeding of acorns here at the Institute

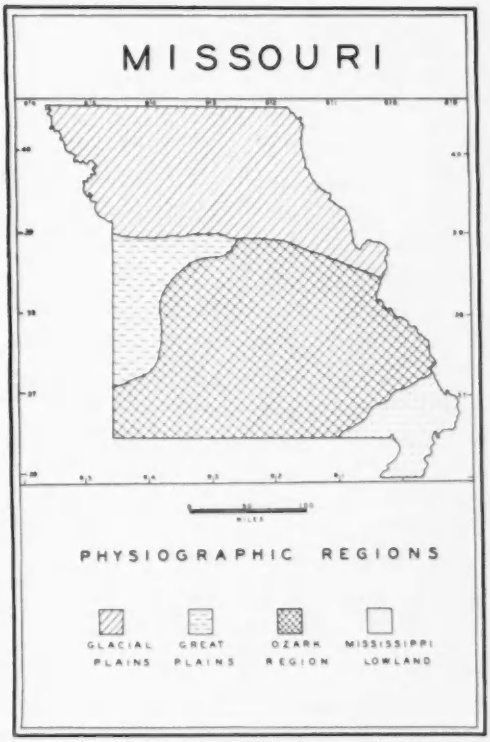

FIGURE 10.—Physiographic Provinces of Missouri (generalized).

was made practically compulsory on account of having no other feed, and our hogs had to be fed. We had a small herd and we bought quite a large quantity of acorns of all kinds just as they were taken from the woods. The area was Macon County, Alabama. In fact it meant quite a nice little profit for the farmers as they could rake the acorns up and bring them in and we paid just a small fee per bushel." The wide development of such feeding would give owners of mast bearing trees a market for their tree crop.

Extension directors of several states failed to classify the special type of mast feeding which was practiced, but most of all indicated the location of the feeding grounds. In nearly every case the type of hog raising is well adapted to the environment. In West Virginia, J. O. Knapp writes that "Mast feeding is of most importance in the more mountainous counties of the state." Mr. L. A. Richardson of Tennessee says, "Due to the fact that we have many mountainous and hilly areas in the state considerable mast is produced and utilized by the farmers for hog feed." Mr. Earl Hostetler from North Carolina states, "Most of the mast feeding of this state is done in the mountain counties in the west; and on many farms consists primarily in the feeding of a few pigs which are to be used for the home meat supply. Practically none of the hogs go into commercial channels." Mr. Grady Sellards points out, "In Kentucky most of the mast feeding takes place in the southeastern part of the state, in other words in about thirty-five mountain counties where large areas of timber are grown." Mr. A. L. Durant says, "The main mast fed in South Carolina is that from acorns where hogs run in the swamps but this method is rapidly disappearing. Very few hogs are fed on mast as it produces an undesirable carcass dark in color and one which does not keep well. Moreover, the swamps are infested with internal parasites." Finally, Mr. M. W. Muldrow of Arkansas indicates, "In certain range territories especially along the river bottoms in the southern part of the state and in some of the forest areas in the hill sections, a few growers will be found who depend primarily on mast as a source of feed for maintaining brood sows and developing feeder pigs for sale."

SHELTER

The shelter problem for mast fed hogs is not a critical one even for type number one where hogs are left in the forest throughout the year. Most producing regions are characterized by mild winters, a fact easily understood when one recalls the states where such feeding takes place, such as Texas, Louisiana, and others.

If the farmer wishes to protect the farrowing sow, he may easily find materials close at hand for constructing a crude shelter of boughs and leaves —provided of course the animal is not so wild and vicious at this time that she will not permit his approach for such purposes. The author has built such shelters for fall farrowing sows and the task takes little effort or experience. Moreover, the isolation and clean ground of the forest encourage less disease than might be encountered in more permanent shelters. Nevertheless there is a larger pig mortality in such a primitive environment, for the young pigs may suffer attack from predatory animals which are just as much at home in the forest as are the swine. Many hogs raised under the second class of mast feeding find protection from the weather in strongly

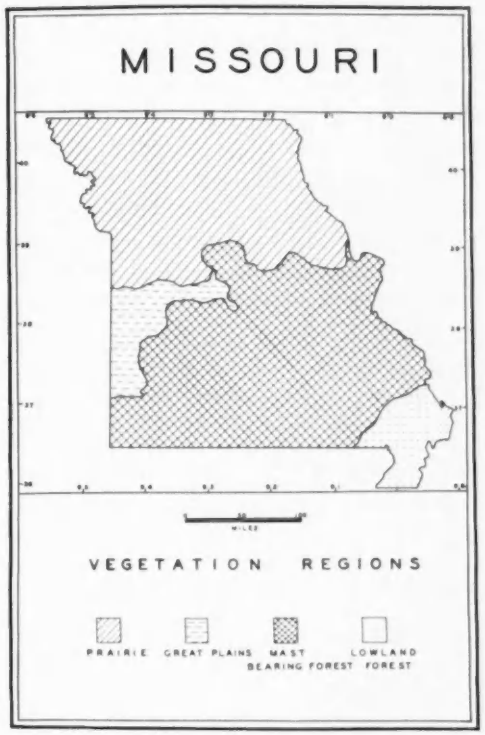

FIGURE 11.—Vegetation Regions of Missouri (generalized).

built houses which form an integral part of the farm building layout.

Cholera losses are likely to be less severe on the range than when pigs are confined to enclosed houses. In the humid shade of the forest, the dust menace will be less and most authorities suggest that dust may be a factor in, and no doubt encourages, a cholera epidemic.

CONCLUSIONS

Many other phases of mast feeding show definite relationships to environment as clearly as those already mentioned. But enough has been said to prove that geographic adjustments are quite as evident in forest swine raising in Portugal, Spain, and Missouri as they are in the dairy lands of Denmark, in the garden agriculture of China, or in the Corn Belt of the United States. Although declining in importance, mast feeding persists in many rugged forested regions of temperate latitudes and even in the tropics. The writer feels that an increase in production might well be encouraged in spite of the control measures instituted by Secretary Wallace a few years ago. Careful research might minimize the soft pork handicap in mast feeding. No doubt consumption would increase if the clogged channels of our distribution system could be opened. At any rate our rugged highlands offer almost unlimited expansion in the raising of tree crops, and one of the best ways of utilizing them is through the medium of mast fed swine.

ESBJERG

William R. Mead

ESBJERG, the youngest of the great ports of Denmark, has been aptly termed Denmark's gateway to the west. It is located at the root of the Cimbrian peninsula, where the isthmus dividing the North Sea from the Baltic reaches its narrowest dimensions. The town and harbor are upon the eve of their seventieth anniversary and the rise of Esbjerg to a commercial center of such prominence within so brief a space of time presents an interesting study in economic geography.

The town has singularly little history. A century ago the site of Esbjerg was occupied by two small cottages—one of which, we find in the annals of the port, was called "Gammelgarden."

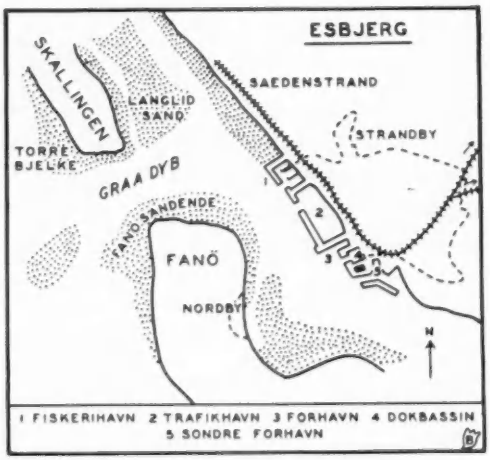

FIGURE 1.—Esbjerg, the North Sea port of Denmark, and the Graa Dyb. In old German atlases, the Graa Dyb is known as the "Grow Tieff" and leads to the little village of Stranby. The subterranean contours of this maritime channel crowd close to the Esbjerg bluff and have been vital in promoting its rise as a port. The figures inserted on the map indicate the more important docks, which have grown northward from the original Dock Harbor. (1—Fiskerihavn, 2—Trafikhavn, 3—Forhavn, 4—Dokbassin, 5—Sondre Forhavn.)

Since the late seventeenth century, Esbirre Klif has been a familiar term to local residents; but the actual name of the settlement is taken from an eighty foot hillock in the neighborhood which is called Esbjerg. The birth of the port dates from 1869, when initial harbor works were begun subsequent to a close examination of the coast of Ribe Amt for a suitable site. The Dock Harbor, which constituted the nucleus of Esbjerg, was soon insufficiently large to accommodate the growing stream of traffic. The tributary urban settlement developed at a speed the tempo of which was accelerated rapidly towards the end of the nineteenth century. A period of wild speculation in the purchase of land and the erection of buildings culminated in 1896. It was followed by a reaction which was accentuated during the wartime years. In the postwar period, Esbjerg made steady progress and claimed a growing proportion of the total trade of Denmark. Since 1860, Esbjerg has grown—with a New World rapidity—from a minute rural settlement to an urban area with a population approaching 40,000. The population of the immediate hinterland has shown a simultaneous increase; while the exploitation of the agricultural possibilities of this hitherto neglected region has been intensified.

In considering specifically the forces which have favored the rise of Esbjerg, we can conveniently focus our attention in the first place upon the economic influences which have stimulated the creation of the port by the human agent. The birth of Esbjerg was a response on the one hand to the revolution in

agricultural practice which occurred in Denmark during the later nineteenth century; on the other hand, to the simultaneous conversion of Great Britain and Germany to industrial states of the first magnitude. The orientation of Denmark, as an agricultural entity, to the markets of manufacturing Europe was made possible both by the technical changes in agricultural production, e.g. the introduction of the separator, and the coincident improvement of transport conditions. The railway was introduced throughout Denmark after the early sixties and linked Esbjerg harbor with the interior in 1874. The iron steamship superseded the sailing vessel about the same time. In toto, it was the internal integration in the agricultural sphere—promoted largely by the spread of coöperation—coupled with the international differentiation of function which gave to Denmark its new economic status in Europe. Esbjerg has, in many respects, become a visible expression of the interplay of these forces. The evolution of the port has been an inherent part of Denmark's struggle to adapt herself to the "total scheme of world relations" as Professor Roxby terms it. While the inception of Esbjerg has been a product of these initial forces, its continued progress has been a manifestation of other latent possibilities. Esbjerg is an essentially dynamic entity.

In the purely geographic field, the locational factor takes precedence over the topographical factor in the instance of Esbjerg. The geographical location of the port is unique along the west coast of Jutland. The North Sea coast of Denmark is, in its entirety, as repulsive to settlement as it is unfavorable to shipping. Mariners have not unjustifiably called it the Iron Coast. From Holstein to the Skaw it is devoid of any adequate natural harbor—save, perhaps, the inner reaches of the Lymfiord. Seaward, the land sinks slowly and the wide sands are skirted by a cordillera of duneland. (See Figure 2.) To the east, the barren outwash plains lie in its windy wake. The duneland barrier has been breached south of Blaavand's Huk—continuing in an island chain parallel to the Schleswig-Holstein littoral. Esbjerg lies at the mouth of the first channel which penetrates the dunes and claims the protection of the isle of Fanö. The port is located in a position which is, at once, on the shortest route to the British market and which is the point on the west coast of Denmark most proximate to the capital—Copenhagen. Figure 3 illustrates the convergence of rail routes upon Esbjerg

FIGURE 2.—Along the West coast of Jutland, a cordillera of duneland has been massed together by wind and wave. This illustration of the North Sea coast of Fanö—the island which lies off Esbjerg and represents a detached portion of the outwash plain—reveals the extent to which Esbjerg harbor is protected by a natural breakwater.

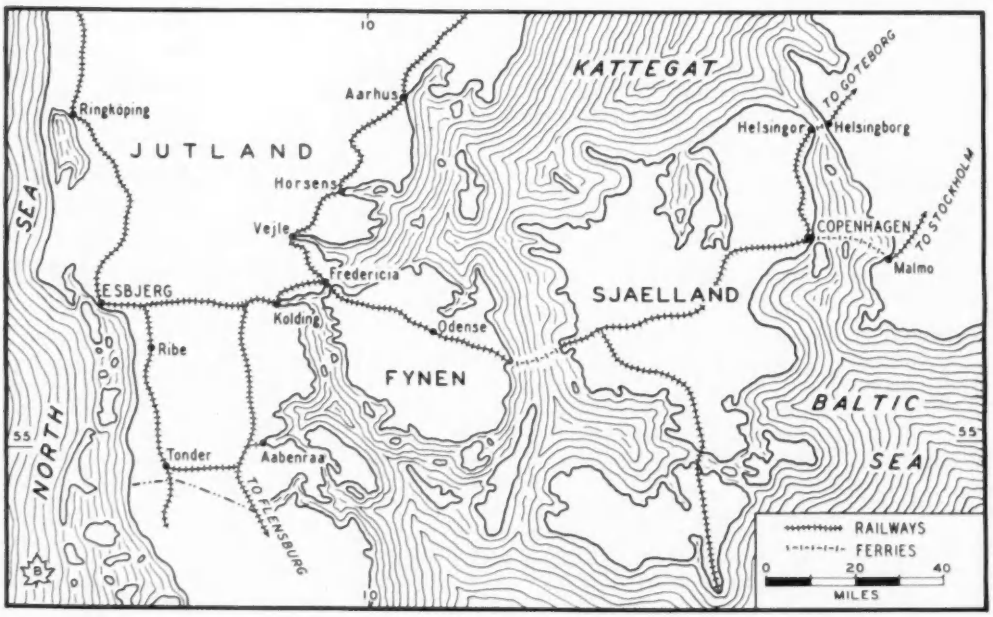

FIGURE 3.—Esbjerg and the routeways which open up its hinterland. The major axis about which the trade of the region revolves is defined by the railway linking the Danish islands and southern Sweden to the North Sea coast.

and its direct communication with the Danish islands of Fynen and Sjaelland.

Turning to the topographical position of Esbjerg, we recall at once the bluff of land from which Esbjerg derived its name. The end-moraine cliff, which is crowned with the prominent water tower, falls away rapidly to the south of the town and is succeeded by the belt of polders which stretches away to the Elbe estuary. The town benefits in many ways from its elevated site. The morphology of the land was an important factor according Esbjerg precedence over Ribe and Ringkoping in the initial decision about the site of the west coast port. But the recurring theme in the historical evolution of this part of the Danish coast has been the accessibility of the land from the sea. The primary factor in the topographical position of Esbjerg has been, therefore, the Graa Dyb. The submarine channel of the Graa Dyb is illustrated in Figure 1. It gives to Esbjerg a natural waterway of some 20 feet and is a unique approach to the littoral of Jutland. The Graa Dyb eliminated the choice of Nordby (on Fanö) or of Hjerting as possible alternatives for Esbjerg. The harbor works of Esbjerg have been built out into the sea towards the Graa Dyb and dredging has made the port accessible for vessels of 10,000 to 15,000 tons. Harbor works at Esbjerg have been rendered less costly and more permanent by several factors. In the first place, the port is protected from the full force of the North Sea gales by the island of Fanö. The extensive moles which characterize Aarhus are therefore dispensed with. Secondly, excavation into the glacial deposits which skirt the coast has been easy. Thirdly, there has been no tributary river to silt up the port. The chances of a winter freeze are, of course, very remote.

Esbjerg is essentially a town which

is tributary to the harbor. Unlike Aalborg, Aarhus and Odense, it is not a manufacturing center of any consequence. In estimating the rôle played by Esbjerg in Danish economy it is almost wholly upon the trading function that we must lay emphasis. Its size is no true indication of the volume of its trade. The population of Esbjerg is engaged primarily in the handling of products, not in their transformation. At first sight, therefore, the five miles of quay seem disproportionately large for a town of only 40,000 people. In addition, Esbjerg is essentially an export harbor. After Copenhagen it has the largest export trade of any port in the country. In contrast to the capital its exports are principally the products of the Danish economy. It has no entrepôt trade of importance. It is, par excellence, the point of assembly for Danish agricultural produce and the point of dispatch to the British and German markets. The Central Butter Exportery (Dansk Andels Smorexportforening) is illustrative of the type of factory which is found in the port. An increasing percentage of the bacon exported from the leading Danish bacon factory at Odense also moves over Esbjerg. The number of refrigerator wagons (Kodvogn) which are grouped in the railway sidings parallel to the harbor bear testimony to the trade in perishable consumption goods. Esbjerg is justifiably proud of its position as the largest agricultural export harbor in Denmark.

The import trade of Esbjerg comprises a greater variety of commodities than the export trade; although imports fall into the four leading groups which characterize the commerce of Denmark as a whole: grains, fodder, coal and coke, and oil. The silo and the mountainous heaps of coal and coke are an integral part of the scene at all of the larger Danish ports. Subsidiary imports include timber, hemp and jute, colonial products, etc. The town possesses a rope making factory of some importance (Tovvaerksfabrik), the manufactures of which are demanded both by the fishing industries and the agricultural hinterland. In contrast to the export trade which assumes nation-wide proportions im-

FIGURE 4.—Esbjerg is a refueling port and the bulk of the coal used is drawn principally from Great Britain. Coal is imported into Esbjerg from the northeast fields of England as cheaply as it is imported by the Thames estuary ports. As with the other Danish coastal centers, the coal supply is also the chief source of light and heat. Denmark is, of course, devoid of the hydro-electric power resources which characterize the rest of Scandinavia.

ports are destined essentially for local distribution.

Any consideration of the port of Esbjerg must lay emphasis upon its function as a fishing port. The construction of the Fish Harbor is the work of the present century and represents the realization of a latent function of the port. Today, Esbjerg is the largest fishing harbor in Denmark and possesses accommodation for some six hundred vessels. (See Figures 5 and 6.) Half of the country's North Sea fishing fleet is concentrated in this port and the bulk of the fish intended for sale in foreign markets is landed here for preparation and re-export. The rise of the Danish fishing industry as a commercially important proposition and

FIGURE 5.—This forest of masts is a typical sight in Esbjerg harbor. The type of fishing vessel which is concentrated in Esbjerg is the combined sail and motor ship. Sails still supply important motive power; while mechanical energy is used for working machinery. The vessels are either owned by individuals or by small companies; there are no large syndicates.

the development of Esbjerg have been mutually interdependent. The artificial harbor at Esbjerg provides a secure anchorage combined with every facility required for the sale and rapid transport of fish. The new harbor works at Hantsholm in Thy will eventually offer additional refuge along a coast devoid of natural shelter; but they cannot hope to attract from Esbjerg any of its trade in fish. The bulk of the fish handled at Esbjerg is sold as "wet" fish and the great ice plant at the main entrance to the Fish Harbor has contributed greatly to the development of the trade. Markets are held daily in the fish hall which lines the quay. It will be seen from Figure 1 that the Fishing Harbor lies to the north of the principal docks—a direction in which future expansion of the port is most likely to occur.

The town of Esbjerg is divorced from the harbor by the end-moraine cliff which runs the length of the sea front. This morphological feature has had a happy influence upon the urban landscape; because it has tended to promote a segregation of the commercial and residential areas. The core of the town reflects the influence of the nineteenth century boom and is almost entirely without the functionalist form of architecture which has thrust itself into the hearts of the other Danish ports. Brick is the chief constructional material; the absence of building stones having played an important part in the history of the adjacent regions, e.g. the problems of empoldering the watten. The main artery of the town (Kongensgade) runs parallel with the edge of the bluff. The newer quarters press inland and to the northeast, absorbing outlying village settlements, e.g. Strandby. Their stiff checkerboard plan is extended over the gently undulating morainic landscape. The lower land to the southwest of the urban area has retarded settlement as well as expansion of the harbor. Here, the marine clays have been exploited for brick and tile manufacture. The center of gravity of the port tends to move slowly northward.

The commercial connections of Esbjerg are principally with Great Britain and there are regular routes between the Danish port and Hull, Grimsby, London, and Harwich. Passenger traffic with England concentrates on the latter route—which has been operating for the past sixty years. The United Steamship Company of Denmark maintains a daily service during the summer months. There are also regular sailings to Hamburg and Antwerp. Like the other ports of Denmark, Esbjerg has supplemented steamship routes by air routes. It is in daily air communication with Copenhagen and the leading ports of the country.

In antithesis to the other great ports of Denmark, which combine the national and regional functions and have acquired their characteristics through generations of continuous development,

Esbjerg is primarily a national functionary the creation of which must be attributed to specialized trading within the European economy. It is no composite phenomenon deriving its present importance from a variety of geographic relationships which have persisted from the past and have been modified to fit in with the present. It is essentially a simple expression of the demands of modern commerce. As a focal point for southwestern Jutland, its importance has been rather the result of geographic momentum.

It can be said with justification that modern Esbjerg has become heir to the function of mediaeval Ribe. It is no new thing for southern Jutland to feel the pulse of trade. Since the earliest days of Danish trading, commercial life has throbbed vigorously in this corner of the land. The vitalizing influences which were crowded into this narrow isthmus naturally converged upon the western coast. The west had contact with the world beyond the restricted confines of the virtually closed Baltic Sea. Some twenty miles to the south of Esbjerg, on the zone of contact between the "geest" and the watten, is situated the thousand year old city of Ribe. For more than five hundred years Ribe was the chief commercial center of Jutland. Land and sea were joint partners in contributing to its preeminence and in early times the town knew a prosperity comparable to that of the mediaeval Hanseatic cities. But like many other former trading centers, the location of Ribe hindered its continued predominance with the revolution in shipping which occurred in the eighteenth century. The commerce of Ribe was tributary to the Nipsaa—the river upon the banks of which the city was founded. (See Figure 9.) Its position as a great international market was dependent upon the maintenance of intimate contact with the sea. Two principal forces united to bring about the decline of Ribe in the sixteenth and seventeenth centuries. Land and sea now seemed to enter into a conspiracy against the city. The watten coastline of Schleswig-Holstein has experienced a steady emergence for at least a thousand years and this, coupled with the natural silting up of the river, has slowly obstructed the main artery of communication between Ribe and the sea. Emergence became manifest to the detriment of Ribe soon after the Renaissance. Simultaneously, the North Sea made grievous inroads upon the

FIGURE 6.—The wealth of available coastal fisheries of Denmark has only recently been realized. Improved conditions of marketing have been the principal spur to progress. Industrialization of the fishing industry has been vigorously pursued in Esbjerg. In the background of this illustration may be seen the auction halls, ice plants, and smoking rooms (for herring) which are the appurtenances of the export trade.

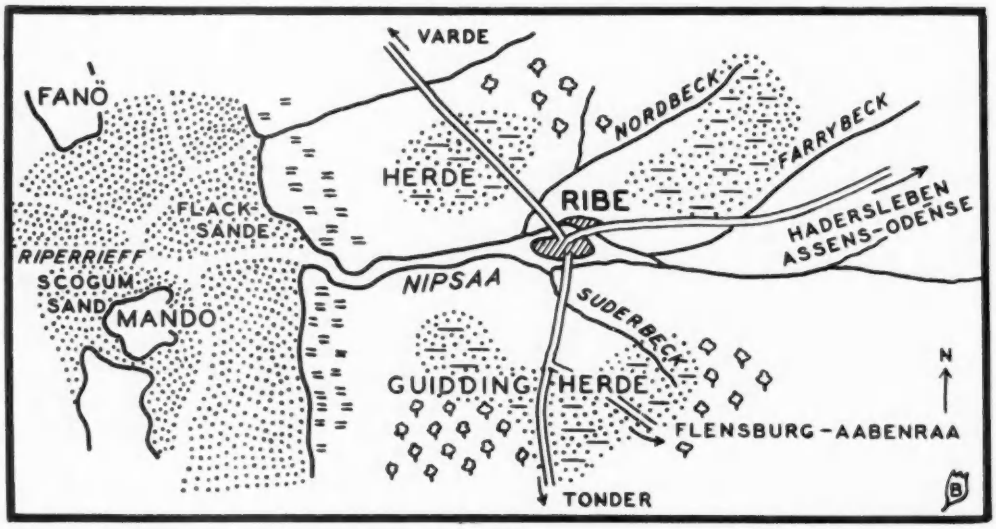

FIGURE 7.—The site of Ribe occupies what Miss Semple has defined as the Inner Edge of the coast. Its retired location and the seaward protection formerly accorded by the Riberhus fortress provide an analogy to the Hanseatic cities of the Baltic littoral of Germany. The site provides a distinct contrast to that of Esbjerg.

watten and floods added to the burden of other natural phenomena. On the economic side, apart from the host of problems associated with the decline of the guild system, the growing tonnage of shipping spelled the doom of up-river ports such as Ribe. Unlike the Graa Dyb, which approaches closely to the bluff of Esbjerg, the Ribe Dyb is both more constricted and more shallow off the estuary of the Nipsaa. Shipping experienced increasing difficulty in reaching Ribe from the sixteenth century onward. The trade of Ribe gradually dwindled. At first, cargoes were exchanged on the island of Röm which performed the function of a primitive outport for the city. Eventually, however, Tonder and the German ports to the south succeeded to the trade of Ribe and with the decay of the Danish Empire, Ribe sank into blissful obscurity.

Ribe itself is a town of absorbing interest; but it is not upon the history of this port that our attention is focused. It is the comparative relationship of Ribe and Esbjerg that is of immediate relevance. The maritime routeways which hitherto converged upon the Nipsaa are now concentrated upon the Graa Dyb. Analysis reveals that these contacts have been modified surprisingly little either in direction or structure. We have noted above the regular sailings from Esbjerg and if we compare them with those of Ribe at the time of its apogee, we find a remarkable correlation. Ribe was in close touch with the North Sea ports of Germany, the Flemish and French ports and also with the east coast of England. Its imports were principally luxury goods—wines, spirits, cloths, etc. A large proportion of necessaries was, however, included, e.g. salt (from Lubeck and the Mediterranean), fish from Norway, hemp from Riga, and cereals to supplement the home crop. The exports consisted chiefly of agricultural products and derived manufactures. Butter, leather, skins, pork, hams, and live animals were most prominent. Adam of Bremen, the

mediaeval scholar, noted that excursions from Ribe journeyed as far as the Near East; while A. Bugge, a modern German writer, states that in former times Ribe was the chief harbor engaged in trade relations with Great Britain. (A. Bugge, "Die Nordeuropaischen Handels-und Verkehrswege im frühen Mittelalter," 1906. Vierteljahrsschr. f. Sozial u. Wirtschaftsgesch.)

Today, we see vessels engaged in Mediterranean trade lying in Esbjerg harbor. Esbjerg has also succeeded to Ribe in the British relationship. King's Lynne and Yarmouth were the leading ports on the English coast engaged in exchange with Ribe. The transposition of the English terminus to Harwich offers a striking parallel to the Danish substitution of Esbjerg for Ribe. In each case the decay of the older port has been attendant upon inaccessibility in the light of changing conditions in maritime exchange. Again, the early commerce in live animals (cattle and horses) has had a remarkable counterpart in more recent times. In seventeenth century prints we see a panorama of Ribe rising from its water-gorged meadows and in the foreground herds of cattle being driven to the harbor front for export to the Netherlands. There has, until recently, been a vigorous trade in live animals between Esbjerg and Antwerp. The former trade in hemp has been supplemented by imports of jute. Salt, which was a commodity of such vital significance in the Middle Ages, when it constituted virtually the only preservative, has fallen to a minor position in the trade returns of the region. Ice is its current equivalent. Refrigeration, in fact, is the *sine qua non* of the "technical" side of the exports of Esbjerg.

The nodality of Ribe can be appreciated from such early maps as the simplified copy in Figure 3. Ribe was a focal point for longitudinal as well as for isthmathian roads. Three principal routes radiated inland from the city, viz. the Kolding-Middlefart-Odense route; the Hadersleben-Assens-Odense route; and the Appenrade road. When

FIGURE 8.—Panorama of Ribe. In the foreground are seen the marshes. The cathedral is the focus of the city and commands wide views over the polders. In former times the tower was an important eminence in military strategy. No less did it indicate to the mariner the end of a hazardous journey along the North Sea coast and through the tortuous channels of the Ribe "Tieff."

comparing these interior communications with those of Esbjerg, we must remember that the latter port gains even more from its isthmathian situation than Ribe. Landward routes are of more consequence for modern Esbjerg than they were for mediaeval Ribe. The ecclesiastical, civic, and military functionaries who took the road to Ribe have their equivalent in the stream of travellers which converges upon Esbjerg and which is destined for northern Europe. We have spoken of Esbjerg as Denmark's gateway to the west. It would be equally true to speak of it as the gateway to northern Europe. It is the point at which Scandinavia most closely approaches to industrial Europe.

Esbjerg has rapid and direct rail and road communications along the Odense-Copenhagen axis. As the terminus of one of Scandinavia's principal

lines of communication, Esbjerg benefits from a steady flow of traffic under normal conditions. Alterations are continually in progress to facilitate movement upon this route. The Little Belt Bridge, for example, has speeded up communications by several hours. Although Esbjerg has arterial links with other prominent cities in Jutland (Aarhus, Aalborg, etc.), its rail connections with peninsular Denmark are less effective than might be anticipated. The nature of its communications, in fact, has been to a certain extent opposed to its rise as a regional center.

While dealing with communications, we may note in passing, an interesting project which was calculated to modify profoundly the maritime importance of the Schleswig coast in the sixteenth century; but was eventually abandoned as a result of the decline of the Danish Empire. It was the Schleswig canal. Christian III planned a canal across the peninsula which was to link Ribe to Kolding by way of the Nipsaa and Königsaa. One can only speculate that the provision of such a structure would have given to the history of Ribe a very different course. The Kiel Canal, its modern equivalent, exerts a modifying influence upon the trade of Esbjerg in spite of its removed location.

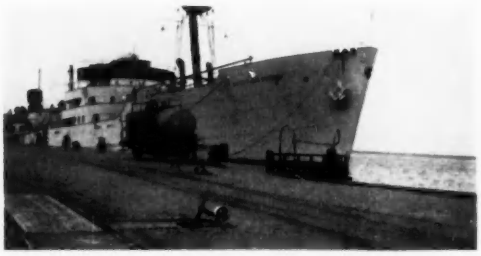

FIGURE 10.—Mediterranean shipping at Esbjerg recalls the excursions from Ribe to the Mediterranean in the Middle Ages. Whereas mediaeval merchants carried luxury goods; the modern freighter transports chiefly foodstuffs. Agricultural products from Denmark provide exchange goods for fruits of the Near East.

FIGURE 9.—Skibbroen—the old quay of Ribe. Products of the known world were unloaded on the banks of the Nipsaa in mediaeval times. The Skibbroen has been succeeded by the five miles of quayage of Esbjerg where commerce of the region is now conducted.

Ribe provides a valuable contrast to Esbjerg; because it bears a kind of ancestral relation to the youthful port and displays a complementary appearance. In Esbjerg there is a harbor which, although artificial, is a response to human forces demanding an outlet on the west coast. In Ribe, a natural harbor has, due to physical, social, and economic factors, suffered atrophy. Esbjerg looks to the future; in Ribe it is the atmosphere of the past which prevails. Ribe is a city in eclipse. The possibilities of its renaissance are remote, for it must inevitably fall within the penumbra of Esbjerg. It has therefore yielded submissively to its destiny as a small market town, a minor administrative center, and the

haunt of a growing body of tourists. The recalcitrant elements of wind and wave no longer challenge Ribe, which slumbers behind the sure protection of her dikes. Yet these very dikes which spell security reflect also the extent to which the city has lost contact with the sea. *Autre temps; autre moeurs.* Ribe has learned to live without the sea. Meanwhile, Esbjerg is still learning to live of the sea.

Esbjerg is an epitome of an age of intensive trading and, like all specialized ports, a symbol of the interdependence of the modern world. We may trace in Ribe the slow strangulation of a city's trade resulting from adverse natural phenomena. Here, economic and political forces making for decline were not lacking; but they were subsidiary to physical influences. The shifting of the center of gravity of the Cimbrian isthmus northward to Esbjerg is an expression of changing geographic values. Esbjerg has arisen due to the ability of the human agent to appreciate the nature of and to compromise with his environment. There are no physical contingencies likely to disturb the equilibrium of the port. On the other hand, political forces are at work which are calculated to promote the decline of Esbjerg—at least for a short period.

The functioning of Esbjerg as a leading export harbor of Denmark depends upon the preservation of peaceful conditions of trading. While Denmark stands to lose much by the rupture of the peace of Europe, perhaps no individual Danish port stands at such a relatively great disadvantage as Esbjerg. Its strategic location in time of peace is transformed into a vulnerable situation in time of war. With the outbreak of hostilities between the Allies and Nazi Germany the flow of trade through this western gateway of neutral Denmark has been profoundly modified. Nazi piracy has intercepted the flow of commodities over traditional trade routes and has in many cases deflected cargoes to German ports. In the conflict of loyalties which divides Denmark between Great Britain and Germany, Esbjerg must inevitably gravitate towards the Reich. The geographical proximity of Esbjerg to the mouth of the Elbe cannot fail to effect a reorientation of trade in this direction. Esbjerg may easily become a vassal port tributary to Germany; while such convoys as may eventually be installed to protect Danish trade with Great Britain, will be concentrated upon ports less proximate to the enemy coastline.

FIGURE 11.—While Esbjerg is a manifestation of a new epoch in the life of the nation, Ribe is a city of the past. The traffic which once animated its streets now enlivens the harbor side of Esbjerg. Ribe, as a precurser of Esbjerg, is a reflection of steadily changing geographic values.

Note: This article was written and accepted for publication before German occupancy of Denmark.

TUNG OIL PRODUCTION AND TRADE

George F. Deasy

TUNG oil has assumed a position of considerable commercial and industrial importance during recent decades. It now ranks as one of the world's essential raw materials and is a trade commodity of international significance. It is particularly important to China and to the United States—as an export commodity of the former country and an import item for the latter.

Tung oil has just recently become the outstanding export of China. In 1913, it represented less than one per cent of that nation's export. Tung oil then ranked eighteenth in the list of export commodities. In recent years, China's exports of the oil have expanded to over 200,000,000 pounds annually, valued at more than twenty million dollars (Figure 1). That commodity now ranks first in value among her exports, accounting for over ten per cent of her total annual shipment of goods (Figure 2).

The recent rise in Chinese exports of tung oil has been matched by increased imports of that commodity into the United States. It was as late as 1905 that American manufacturers first became seriously interested in the use of tung oil. Only after the World War did receipts begin to assume notable proportions. Today this country imports annually between 100,000,000 and 175,000,000 pounds, which represents between 20 per cent and 30 per cent of our total imports from China. No other Chinese commodity is now so valuable to this country. Tung oil shipments to the United States at present rank with those of palm oil, coconut oil, and cottonseed oil as our leading vegetable oil imports (Figure 3).

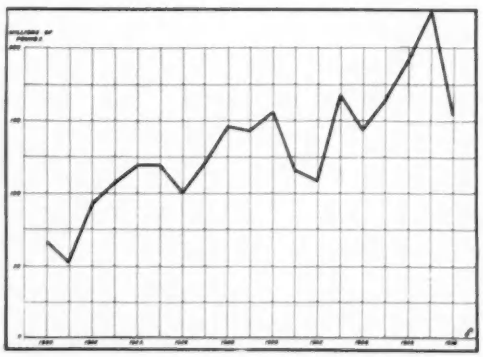

FIGURE 1.—Tung oil exports of China—1920 to 1938. China's tung oil exports have fluctuated markedly from year to year, but the trend has been steadily toward greater volume. A three- to four-fold increase has been recorded during the last decade and a half.

SOURCES AND USES OF TUNG OIL

What is tung oil and what are its uses? Briefly stated, tung oil is the best drying and waterproofing oil of vegetable origin known to science. It is derived from the seeds of the tung tree (*Aleurites fordii* and *Aleurites montana*), found growing in the wild and semi-cultivated state in western and southern China. The fruit of this tree when mature is oval, from two to three inches in diameter, and covered with a hard husk which is dark brown in color. Inside each fruit are three to seven hard brown seeds which contain the white meat from which tung oil is pressed.

The oil from these seeds has been used for unknown centuries by the Chinese for waterproofing and preserving wood, paper, cloth, masonry, and other materials. In fact, it is said that because of this oil the Orient has been able to get along fairly well without

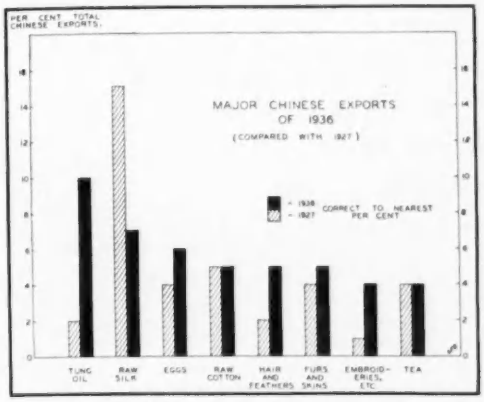

FIGURE 2.—Major Chinese exports of 1936, compared with 1927. The China of yesterday was intimately associated with the export of tea and silk. That concept needs modification today. Since 1935, tung oil has been China's leading contribution to the commercial world.

paint and rubber. Tung oil has come into extensive use in the western world, however, only in the last thirty-five years.

The chief use of tung oil in the United States and Europe is in the manufacture of waterproof varnishes, enamels, paints, and paint driers. Almost ninety per cent of the total consumption of the product in this country goes into varnish manufacture, where it has largely superseded linseed oil in the higher quality products (Figure 4). It is claimed that strictly waterproof varnish cannot be made without tung oil as one of its constituents.

The advantages of tung oil over linseed oil for varnish manufacture are: (a) its rapid-drying characteristics, which permit mass-production methods to be employed in the painting of objects ranging from automobiles to toys; (b) its water, acid, and cracking resistant qualities; (c) the higher gloss it produces upon drying; and (d) the possibility of using cheap and abundant southern rosin and chemical derivatives of rosin with tung oil in place of the rapidly disappearing and costly fossil gums (kauri, manila, Zanzibar, etc.) that were required with linseed oil to produce high quality varnishes. Because of these characteristics the recent widespread use of tung oil in the United States has completely revolutionized the paint and varnish industry of the country.

Tung oil is also used in the United States and Europe in the manufacture of oilcloth and linoleum, as a constituent in the manufacture of certain insulating compounds essential to the electrical industry, for waterproofing cloth and other materials, for the brake-linings of vehicles, and for innumerable other manufactured articles which are extremely important in the everyday life of an industrial people.

WORLD PRODUCTION AND TRADE

The tung oil industry is one of the last in which China holds a position of world supremacy. In fact, as late as 1932 that country was the sole commercial producer and it monopolized world trade in that commodity.

China's chief advantages were: (a) the fact that southeastern Asia was the native home of the tung plant and innumerable wild trees were available for exploitation; (b) the existence of the world's largest market for tung oil in

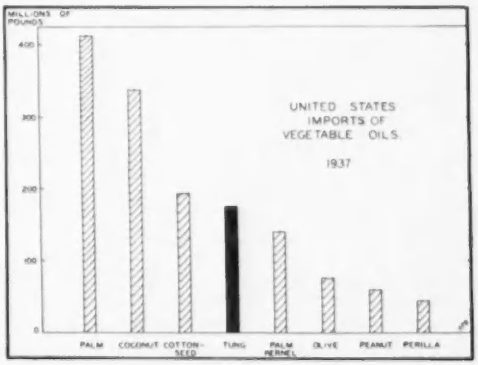

FIGURE 3.—United States imports of vegetable oils, 1937. Tung oil ranks among the major vegetable oil imports of the United States. It has been for some time the leading drying-oil imported into this country.

China, because of the failure of other countries to recognize the value of the commodity until recently (even though it was known in Europe since the sixteenth century); and (c) the plentiful supply of cheap labor in China.

Recently, attempts have been made to introduce the culture of the tung tree into numerous other parts of the world. Many experimental plantings have been made. To date, however, commercial production has begun in only one additional country—the United States. China's leadership is still retained, since the tung oil press of this country is now less than two per cent of total world production (Figure 5).

Commercially, tung oil is likewise dominated at present by China and the United States. Tung oil trade is mainly a movement between these two countries. For decades, China has maintained a monopoly in the export of the commodity, while for a similar period of time this country has consistently taken from two-thirds to three-fourths of the total Chinese export (some twenty to forty per cent of China's total production of tung oil serves her domestic market). Shipments to Europe, the other outstanding industrial region of the world, represent only a small fraction of the amount moving to the United States (Figure 6).

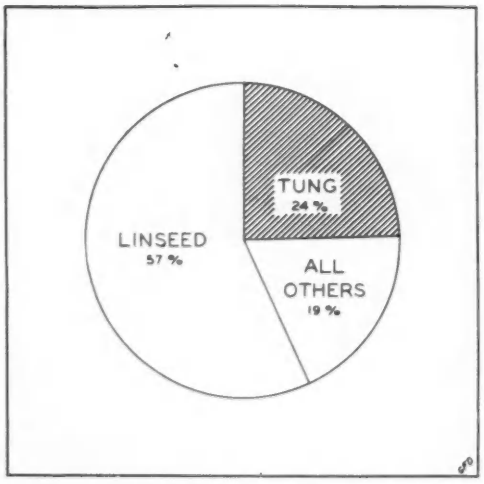

FIGURE 4.—Per cent of oils used as vehicle by paint and varnish industry of the United States, 1935. Linseed oil still forms the backbone of the paint and varnish industry, but tung oil is rapidly becoming a serious contender.

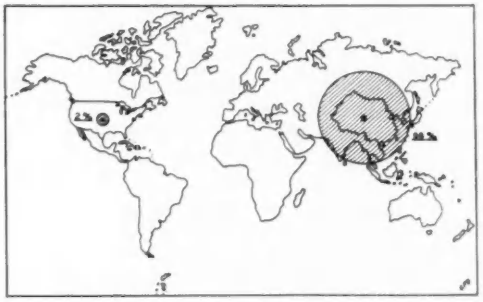

FIGURE 5.—Tung oil production, 1938. Commercial tung oil production is at present limited to two countries, China and the United States. Despite the rapid growth of the tung industry of this country, China still ranks supreme.

The vastly greater significance of the United States market, as compared with the European market, is not normal for most commodities of international trade. Several factors are involved in this unusual situation: (a) the existence of extensive flaxseed acreages in Europe and the strong position of the linseed oil industry there have for many years made the entry of other drying-oils difficult, regardless of their qualifications; (b) the relatively low purchasing-power of the average European buyer of varnishes and paints has forced him to remain content with the inferior, but somewhat cheaper, linseed oil products; (c) the conservatism of the average European manufacturer has caused him to hesitate in changing his formulas to use a relatively new and untried product such as tung oil; and (d) the reluctance of European countries to become dependent upon an essential raw material which is available only from a single distant source (which might become inaccessible during time of war) has retarded the substitution of tung oil for linseed oil.

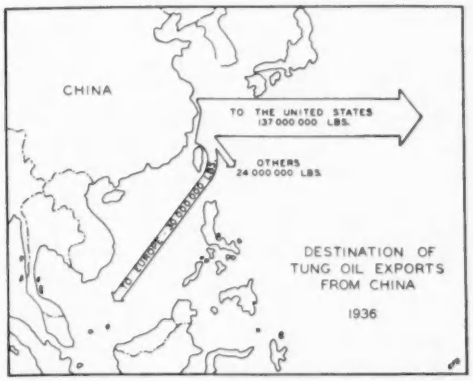

FIGURE 6.—Destination of tung oil exports from China, 1936. For decades the United States has been the major market for China's tung oil. This country has consistently taken from two-thirds to three-fourths of China's total annual export of that commodity.

Germany is normally the leading European outlet for tung oil because of its highly developed paint and varnish industry. The United Kingdom ranks second in Europe, and France third. The movement of Chinese tung oil to places other than Europe and the United States is small, due chiefly to the lack of industrialization in other areas. Japan is the only other significant purchaser that need be mentioned.

CHINESE PRODUCING, MILLING, AND EXPORT CENTERS

The tung oil industry of China is located chiefly in the western and southwestern sections of the country. The whole or portions of five major contiguous geographic regions are involved: the Szechwan Basin, the South Yangtze Hills, the Central Mountains, the Southwestern Plateaux, and the Southern Coastal Hill Region (Figure 7). These five areas combine to form China's "Tung Belt," which supplies the bulk of that nation's tung crop (Figure 8). A small, detached center is located at the eastern extremity of the South Yangtze Hills, but its output is relatively insignificant.

Obviously, only a small percentage of the land within China's "Tung Belt" is actually given to tung production. In general, all areas of level or gently sloping land and possessing good soil are in food crops, a necessity in this region of dense population, rugged topography, and inadequate transportation. Likewise, a large percentage of the region is too rugged, lacks sufficient soil covering, or is too high in elevation to support tree growth. Only the intermediate not-too-rough and not-too-level sections with fairly poor soil are used for tung production. In these intermediate areas tung trees may be few and scattered in certain localities and in dense groves elsewhere. Each

FIGURE 7.—Tung oil producing centers of China. Each dot represents a major tung oil milling center, consisting of varying numbers of small native mills. The actual tung-growing areas are located in proximity to each milling center, the territory served by each group of mills being primarily determined by the transportation facilities available. Numerous mills or groups of mills of minor importance are not shown on the map. The broken lines represent the approximate areas in China supporting appreciable numbers of tung trees, as determined by the distribution of mills and available descriptive literature.

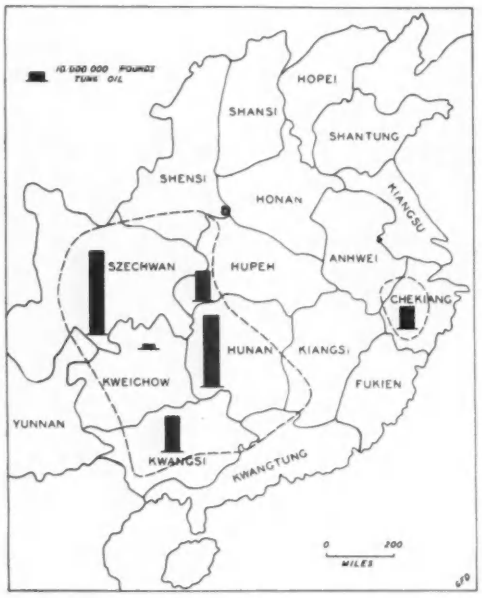

FIGURE 8.—Estimated Chinese production of tung oil, by provinces, 1938. The major tung oil producing provinces of China are Szechwan and Hunan. Kwangsi, Hupeh, and Chekiang are of lesser importance. The actual production of tung fruit in Kweichow is considerably larger than the tung oil production figures would lead one to believe. This is due to the fact that much Kweichow tung fruit moves downstream to Szechwan and Hunan milling centers before being crushed. Hence, a true picture of the significance of the tung growing industry in Kweichow is lacking.

farmer has his own few trees or his grove of trees, located on that portion of his holding which is unsuited to the production of the all-important food crops (Figure 9).

The boundaries of China's "Tung Belt" are partly climatic and topographic, and partly economic. The extensive growth of the subtropical tung tree northward of the present producing area is retarded by cold winters (that kill the trees), late spring frosts (that damage the blossoms), and decreasing precipitation. To the west, increasing altitude and ruggedness and coincident cold winters, late springs, and cool summers bound the "Tung Belt." The present eastern and southern boundaries are thought to be largely economic, since natural environmental conditions continue essentially unchanged (in the broad sense, at least) both eastward and southward to the Pacific. It is true, the climate changes southward from subtropical to tropical (i.e., without a cool dormant season), and the true tung tree (*A. fordii*) requires such a cool season. However, another species of tung, a tropical variety (*A. montana*), thrives in such an environment and is widely grown there in place of *A. fordii*. Although statistics are not available to support this contention, it is believed that a significant proportion of the arable land in eastern and southern China formerly devoted

FIGURE 9.—Isolated group of young Chinese tung trees. They are usually found in small stands, either among other trees in a forest or in the open amid cultivated fields, usually on hilly lands and on stony or sandy soils where most other crops do not thrive. They are seldom grown in large plantations, as is the customary practice in the United States. (Courtesy of H. W. Bennett and the Werner G. Smith Company.)

to tung trees has reverted to food crop production because of the rapidly growing population of those areas.

Within the "Tung Belt" of China and the small center to the east, thirteen major producing areas have been distinguished (Figure 10). Each of these consists essentially of the territory drained by one of the larger tributaries of the Yangtze Kiang or the Si Kiang. Each consists of a fairly compact area of tung tree production, a group of tung-oil milling centers, and a single (in rare cases two) major collecting and transshipment point. Since the oil to be exported almost invariably moves by native boat from the milling centers to the export ports, the collecting and transshipment points are on the downstream margin of each producing area.

Efforts to establish modern centralized tung oil mills at Hankow, Shanghai, Hong Kong, and other strategic points have all failed. Instead, innumerable small primitive local mills, scattered throughout the tung producing region, continue to account for almost the total Chinese tung oil press (Figure 10).

The major advantage of the local native mills over large centralized mills is primarily a matter of reduced transportation costs. Only some twenty per cent of the whole dried tung fruit, and only thirty-five per cent of the seeds, consist of oil, while the press cake is poisonous and cannot be used as a livestock feed. With the costly and inadequate transportation facilities existing in the greater part of the "Tung Belt," it pays to extract the valuable oil from the fruit as soon as possible before shipment is attempted.

The major potential advantage of modern centralized mills would be the somewhat greater percentage of oil they could extract from the seeds. This increased oil yield is insufficient to offset the much more expensive transportation costs involved in moving the whole tung fruit or tung seeds great distances.

During "normal" times from eighty to ninety per cent of China's export of tung oil is collected at and exported from Hankow, in the Middle Yangtze Valley. Hong Kong, in South China, handles the bulk of the remainder. A small quantity of tung oil from the

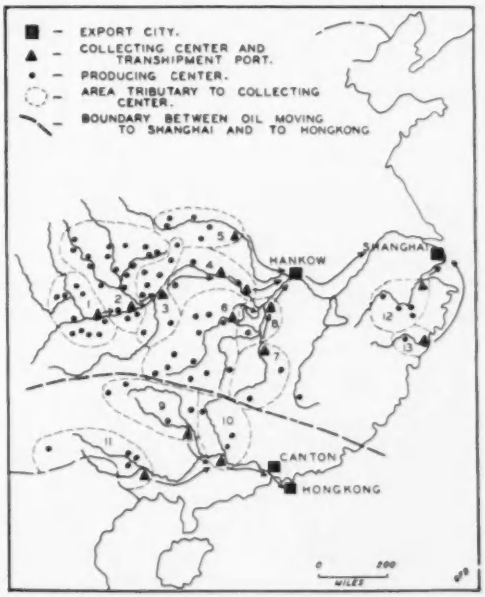

FIGURE 10.—Movement of Chinese tung oil to ports. The boundary lines between oil moving to Hankow and Shanghai and that moving to Hong Kong refers to conditions during normal times in China. At present, most of the Yangtze Basin production is being carried overland or down streams to Hong Kong. Each of the thirteen tung oil producing areas shown on the map is named after its major collecting and transshipment center, and consists essentially of the territory drained by one of the larger tributaries of the Yangtze Kiang or Si Kiang. The areas are: (1) Luchow Region (Min River), (2) Chungking Region (Kialing River), (3) Wanhsien Region (Wu River), (4) Ichang and Shasi Region (Middle Yangtze—in part), (5) Laohokow Region (Middle Han River), (6) Changteh Region (Yuen and Tzu Rivers), (7) Changsha Region (Hsiang River), (8) Yochow Region (Tungting Lake), (9) Liuchow Region (Lung and Liu Rivers), (10) Wuchow Region (Kwoi River), (11) Nanning Region (Upper Si River), (12) Hangchow Region (Tsientang River), (13) Wenchow Region (Wu River).

Lower Yangtze Valley producing area is marketed through Shanghai. Hankow has several significant advantages for tung oil exportation over its competitor ports: (a) it is immediately downstream on the Yangtze from China's outstanding tung oil producing region, and (b) it lies at the head of stream navigation for large steamers during certain periods of the year.

Considerable variations occur, however, from year to year in the relative amounts of tung oil shipped through Hankow and Hong Kong. This is a reflection of comparative transportation, political, and military conditions in the Yangtze and Si Kiang Basins. When river conditions are poor, or when political or military affairs are unsettled in the area tributary to one port, much oil is diverted for export through the other. This is facilitated by the fact that a distance of less than one hundred miles separates the tributaries of the Yangtze from the headwaters of the Si Kiang (Figure 10).

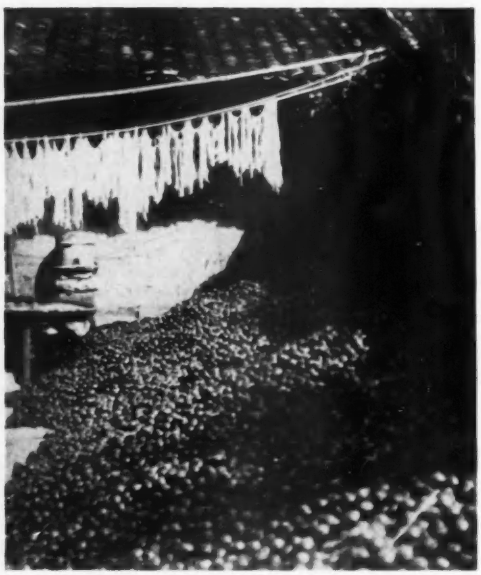

FIGURE 11.—Tung fruit drying in a Chinese courtyard. The tung fruit is exposed to the weather to loosen the tough husks and permit the oil-bearing seeds to be easily extracted. (Courtesy of H. W. Bennett and the Werner G. Smith Company.)

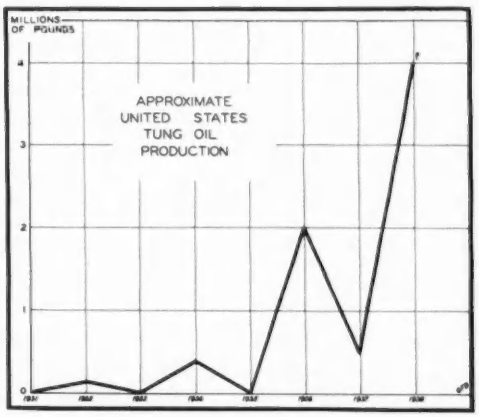

FIGURE 12.—Marked fluctuations in annual output have characterized the tung oil industry of the United States ever since its inception. The basic cause for the periodic decline in output has been the severe spring frosts which occur every few years and damage the tung blossoms. The excessive amount of damage done can be attributed in part to the youthful character of the trees and to the initial selection of lands with poor air drainage by certain planters. Improvement should be noted in coming years.

The present Sino-Japanese War operations in the Lower Yangtze Valley, for example, reduced to insignificance the tung oil exports of Hankow, and caused Hong Kong exports to increase three hundred per cent in a single year. Such conditions are only temporary, however, and when hostilities cease and normal geographic controls once more prevail Hankow can be expected to regain its accustomed outstanding leadership in the tung oil export trade of China.

UNITED STATES TUNG INDUSTRY

Tung fruit and tung oil production constitute one of the truly "infant industries" of the United States. The first tung seeds from China were sent to this country in 1902 and 1903, but, despite the considerable experimental work which took place in the southern states for over two decades, the tung industry as a commercial enterprise only began in 1925. Since that time

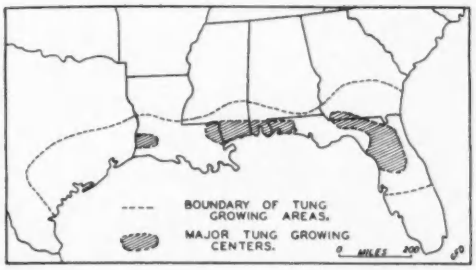

FIGURE 13.—Tung tree growing areas of the United States, 1939. The present potential tung growing area is confined to the southernmost parts of the South. The future may see the extension of this American "Tung Belt" farther northward to regions possessing a climate somewhat analogous to the northern tung producing areas of China. The major tung growing centers are now three in number. Of these the central one is by far the most important.

American tung acreage has rapidly expanded to an estimated 175,000 acres in 1939.

The first small commercial shipment of United States tung oil to consuming channels occurred as late as 1932. Today, several million pounds of domestic tung oil are marketed annually (Figure 12). While this represents but a small fraction of the present world output, it nevertheless constitutes the only sizeable commercial production outside of China.

The present "Tung Belt" of the United States is restricted to a rather narrow east-west strip of land, about one hundred to one hundred and fifty miles wide in most places, that embraces the southern portions of the states of Georgia, Alabama, Mississippi, Louisiana, the northern half of Florida, and the Gulf counties of Texas (Figure 13).

The boundaries of this "Tung Belt" are essentially climatic. The northern margin is determined by temperature condition. Winters must not be too severe or the warmth-loving tung tree will be killed; late spring frosts must be absent or rare or the blossoms will be destroyed. The extent to which winter temperatures can drop without seriously damaging the tung tree is not definitely known, (1) because of the high percentage of trees in this country not yet mature (mature trees stand the cold better), and (2) because of variability in the period of dormancy among individual trees. Hence the northern boundary cannot be drawn with any degree of finality. However, present concensus of opinion agrees that it should extend from somewhere in southeast Texas, eastward to southeastern Georgia.

There is a growing thought that perhaps the northern boundary might be extended. It is certain that many of the tung trees of China are grown under somewhat more rigorous climatic conditions than those prevailing in the present "Tung Belt" of this country (Figure 23). Hence, it is perhaps reasonable to expect the future culture of that crop in the United States to extend northward of its present position.

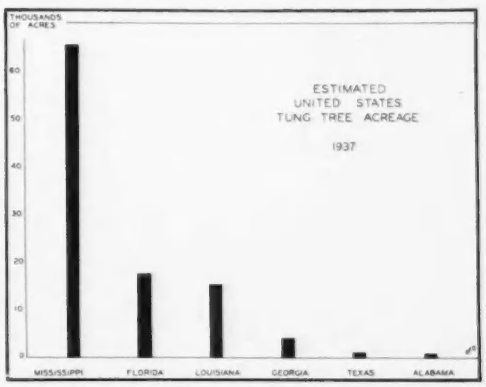

FIGURE 14.—No official figures on tung tree acreage in the United States have been available since the last census, despite the rapid growth of the industry during recent years. A reliable but unofficial estimate placed the total tung acreage of this country at 103,000 acres in 1937. Estimates for 1939 run up to 175,000 acres. A considerable portion (approximately one-half) of both the 1937 and the 1939 estimates consists of acreage that is worthless for the production of tung oil, due to improper selection of land or neglect of the groves. Until recent years, Florida led the other states in tung tree acreage. Today, Mississippi is outstanding in that respect, its leadership being partly due to a few exceedingly large plantings.

FIGURE 15.—A mature tung grove in the Florida section of the "Tung Belt." These trees are nine years old. Note the abundance of fruit. Such trees will continue to yield for some forty to fifty years, if given the proper care. (Courtesy of Florida Department of Agriculture.)

This tendency will be aided by the selection of seed from trees that seem better able to resist cold and to blossom late in the spring. Individual tung trees have borne fruit as far north as central North Carolina, but tung *groves* would not withstand similar conditions at present.

The southern boundary of the American "Tung Belt" is likewise determined by temperature conditions. While the tung tree (*Aleurites fordii*) is a native of warm regions, it is not a true tropical plant. It is deciduous and requires approximately a three-month period of complete dormancy. The southern boundary is therefore drawn to include only such areas in southeastern United States as have temperatures sufficiently and consistently low throughout December, January, and February to keep the tung tree in a state of rest. Plantings farther south, in southern Florida and the West Indies do not grow or produce satisfactorily. The trees usually lose their leaves three or four times a year under such conditions and only an occasional fruit is produced. It is as yet impossible to definitely delimit the southernmost boundary of successful commercial production in Florida, because of insufficient data. However, the boundary runs somewhere through the middle of the peninsular portion of the state.

The western boundary of the American "Tung Belt" exists partly in response to climatic conditions, and partly to economic factors. Generally a minimum annual rainfall of thirty inches is considered essential for the tung tree, and best results occur with rainfall of over forty inches a year. Hence the western limit is approximately the 98 meridian in eastern Texas. West of that line, rainfall is insufficient or too irregular for successful growth of the tung tree. However, the tree could be grown in considerable numbers west of the present boundary on irrigated land. Its exclusion from the Pacific Coast and southwestern regions is primarily due to the fact that tung yields smaller returns per acre than several other competitive irrigated orchard and vegetable crops, despite the original over-optimistic reports to the contrary.

Within the American "Tung Belt" thus outlined, *commercial* tung production is still further restricted by certain

FIGURE 16.—Young tung tree plantation in Florida. These trees were three years old when the photograph was taken. While they have a few fruit, they will not reach the true productive stage until the fifth year. Several million such trees have been planted in the American "Tung Belt" recently, covering tens of thousands of acres of otherwise useless cut-over pine lands. (Courtesy of Florida Department of Agriculture.)

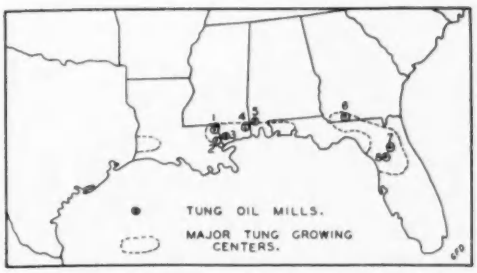

FIGURE 17.—Tung oil mills in the United States, 1939. The first tung oil mill in the United States (and the first modern tung mill in the world) was established at Gainesville, Florida, in 1928. As late as 1935 there were only two mills in existence in this country, the second being located at Bogalusa, Louisiana. Today eight mills serve the American "Tung Belt," indicating the rapid growth experienced by the industry during recent years. The eight mills are located as follows: 1. Bogalusa, La. 2. Covington, La. 3. Picayune, Miss. 4. Lucedale, Miss. 5. Citronelle, Ala. 6. Cairo, Ga. 7. Brooker, Fla. 8. Gainesville, Fla.

more localized factors. First of all, the soil requirements of the tung tree for maximum output are rather exacting. Fertile soils are preferable to those that lack adequate plant food. Acid soils are best; alkaline soils are definitely injurious and result in stunted growth. Good surface and sub-soil drainage is also necessary for best growth of the tree. The ideal soil is a fertile sandy loam that can be easily drained but remains fairly moist. This does not mean, however, that the tung tree cannot and is not being successfully grown on other types of soil—from infertile sands to heavy clay loams. Conditions in China, where the tree is grown in many and poor types of soil, suggest that the tung tree will produce fair returns even under conditions that are far from ideal. But in southeastern United States, where soils of many varieties are available at low cost, it has profited the tung planter to select only those best suited to the tree.

In addition to the soil factor, air drainage must also be considered. Land planted to tung trees is generally rolling or sloping to minimize the danger of late spring frosts. Low flat lands are avoided.

Because of these latter factors, large parts of the present American "Tung Belt" are considered unfit for tung production (although the tung tree will grow in many unfavorable areas with some degree of success). It has been estimated that eighty per cent of the land of that part of Florida lying within the "Tung Belt" is economically unsuited because of poor drainage, alkalinity (limestone origin), or susceptibility to frost due to land surface conditions. Somewhat equivalent proportions of the potential tung areas of the other Gulf States might be considered unfit on a similar basis.

The present distribution of the *major centers* of tung production in the "Tung Belt" is shown in Figure 13. They are three in number, (1) north-central Florida and the adjacent extreme southern border of Georgia, (2) extreme southern Mississippi and Alabama, and adjacent parts of southeastern Louisiana and western Florida, and (3) a small center in southwestern Louisiana. The Mississippi portion is outstanding (Figure 14).

FIGURE 18.—Mature Florida tung trees in bloom. Tung trees are highly ornamental and are especially beautiful when in bloom. Large groves of such trees might add significantly to the scenic attractions of the South to tourists. (Courtesy of Florida Agricultural Experiment Station.)

These three major centers of production offer no criterion as to the relative merits of the various parts of the belt for tung tree culture. Instead, their present predominance is largely due to the initiative of a few individuals or groups in each area, who have set out large acreages of trees in their local territories. Conditions fully as propitious undoubtedly exist within other parts of the belt, but they are at present unused. The reason for this is that the tung industry of this country is still in its "youthful stage." Only when it has reached "maturity" and all or most of the suitable areas are utilized, will the truly superior areas in the "Tung Belt" stand out in true perspective.

FIGURE 19.—An eight year old Florida tung tree with a full crop of fruit. Such heavy yields in the American tung belt are largely the result of the scientific selection of superior strains of trees and suitable soils. (Courtesy of Florida Agricultural Experiment Station.)

Those engaged in the production of tung fruit in the United States have been divided into the following five groups: (1) paint and varnish manufacturers, (2) people receiving most of their income from farming, (3) gentlemen farmers, (4) lumber companies, and (5) promotional interests. Over half the present tung acreage is controlled by gentlemen farmers, while a fifth of the total acreage has been developed by lumber companies as a means of utilizing cut-over wasteland.

Tung groves in this country show an extremely wide range in size. Some are but a few acres in extent; others are huge 10,000 acre establishments. In general the gentlemen farmers, lumber companies, and promotional interests maintain large holdings, while the true farmers and the paint and varnish manufacturers have small holdings (the latter mainly for demonstration purposes). The advantages for profitable production of tung fruit would seem to lie with the large grower because of: (1) the economies of large-scale operation, and (2) the fact that the large grower usually has sufficient capital to see him through the first five non-productive years.

At the present time there are eight tung-oil pressing mills in the "Tung Belt" of the United States. Five of these serve the very important Louisiana-Mississippi - Alabama - western Florida tung growing center; the remaining three are located within the Florida-Georgia center. The small western Louisiana tung center is at present without a mill (Figure 17).

All eight mills are small (although in comparison with the native mills of China, they can be called large), and are widely dispersed throughout the major tung growing areas. This seems a logical development, in view of the fact that only sixteen to twenty per cent by weight of the whole dried tung fruit consists of oil, and the remaining press cake is poisonous and unfit for livestock feed (although it does have fertilizer value).

The present mills include a decorticator and expeller. New types of machinery were not required, since it was found possible to adapt hullers and crushers used for other oleiferous products.

The development of the tung industry in the South promises to furnish at

least a partial answer to several of the outstanding economic problems of that section of the country. (1) To begin with, tung culture will diversify agriculture and help to bring about the more balanced agricultural economy this region so greatly requires. (2) The tree will furnish a potential crop for part of the vast and otherwise useless cut-over pine lands of the southern states. (3) Tung should make an excellent cash crop for the southern farmer, since it can be grown on hillsides and irregular plots of land that would be unsuited to general farming, it is remarkably free from all forms of insect pests and fungus diseases, harvesting is non-critical and can be extended over a protracted period of time, the dried fruit is non-perishable and can be stored for as long as six months so that the farmer can benefit from maximum market prices, shipping damage presents no problem as with the peach and certain vegetable crops, and finally there appears to be an almost unlimited domestic market for as much tung as can readily be grown in the South for years to come. (4) Extensive tung plantings will quite likely result in the development of a considerable milling industry and thus aid in the industrialization of these predominantly agricultural states. (5) With large supplies of tung oil, turpentine, and rosin available in the South, a considerable extension of the paint and varnish manufacturing industry may take place there. (6) A large supply of tung press cake, although poisonous and unfit for livestock, has considerable fertilizer value (tests have shown it to be approximately the equivalent of cottonseed meal as a source of nitrogen) and would augment appreciably the local plant-food supply of the greatest fertilizer-consuming region of the United States. (7) Finally, tung trees are highly ornamental in character and are especially beautiful when in bloom. They might add significantly to the scenic attractions of the South to tourists (Figure 18).

CHINESE VERSUS UNITED STATES TUNG OIL PRODUCTION

Formerly the question was frequently raised as to the possibility of establishing a large tung industry in the United States in direct competition with the cheap labor industry of China. Recent years have proven the ability of the American producers to hold their own in the tung industry.

FIGURE 20.—"Single" (left) and "cluster" (right) types of tung tree fruit. One of the major potential advantages of the United States over China in the production of tung oil is the possibility of increasing yields through the scientific breeding of the trees. Here is an illustration of one of the results of extensive tung breeding experiments being carried on by the Florida Agricultural Experiment Station. The "cluster" (or Florida) variety generally yields larger crops than the "single" type, which is almost universally found in China. Such "cluster" trees are being widely distributed throughout the American tung belt. (Courtesy of Florida Agricultural Experiment Station.)

Advantages of the domestic producers over those of China are as follows: (1) the American tung industry is mechanized; that of China is a hoe and spade affair. Cultivating, hulling, and oil-expelling are all generally done by modern machinery in this country, and it is thought that a harvesting machine to gather the mature fallen fruit will soon be available. In this way, machin-

ery enables one man to do the work of scores of Chinese, and reduces to insignificance the importance of China's unlimited supply of cheap labor.

(2) *More fertile soils* are used for the tung crop in the United States than can be spared in densely-populated China, and the tung tree appears to thrive and yield in direct proportion to the richness of the soil in which it is grown. Also, American producers generally use much more fertilizer than do the Chinese. The net result is higher yields per tree and per acre in this country (Figure 19).

(3) *Greater care* is expended on the tung groves in the United States than in China. In this country tung trees are mostly scientifically cultivated in fair-sized to large plantations. In China the trees are generally not systematically attended and are commonly allowed to grow in the half-wild state. While it is true that the tung tree requires less attention and care than the citrus trees, it nevertheless cannot be neglected if the highest yields and longest productive life of the trees are to be expected.

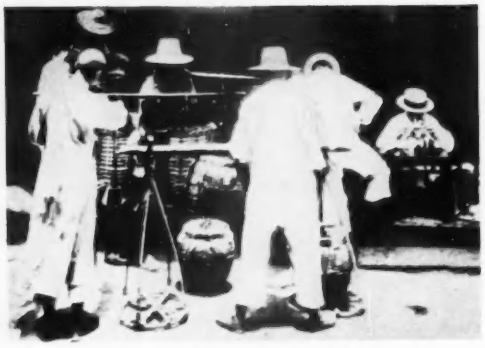

FIGURE 21.—Weighing and testing tung oil at a Chinese port. Formerly the adulteration of Chinese tung oil by the producers and middlemen through whose hands it passed was common. The cheaper vegetable oils, mineral oil, water, and plain mud were the ordinary adulterants. Recently efforts have been made by Chinese governmental authorities to maintain the quality of the oil for export. Examination of all such oil at the export ports is now compulsory. (Courtesy of H. W. Bennett and the Werner G. Smith Company.)

(4) *Better strains* of tung trees have been developed in the United States through scientific studies, and a great future appears for tung tree breeding in this country. There is little prospect for improvement in this respect in China because of the prevailing ignorance of the growers and the wild state of the trees (Figure 20).

(5) *Cheaper transportation* of the tung fruit and tung oil is available in the United States. In China, the fruit is carried on human backs to the nearest native mills; then the oil moves by dangerous and expensive junk passage down the Yangtze or Si Kiang to the export ports. It is estimated that transportation costs for tung oil in China are several times as expensive per ton mile as in the United States, despite our high wages and freight rates. Furthermore, attempts are being made in this country to develop a portable machine to hull the tung seeds in the orchard, so that only seeds and not the whole fruit need be shipped to the pressing mill. This would reduce the weight to be transported by about forty per cent and the bulk fully fifty per cent.

(6) The common Chinese practice of *adulterating* the tung oil with cheaper vegetable and mineral oils is totally absent in the United States. Such practices have recently begun to disappear in China, due to the establishment of more rigorous inspection laws at the ports of export (Figure 21).

(7) American tung is far *more reliable* as to quantity available and prices demanded. In China, civil war, banditry, floods and droughts, uncertain internal taxation, and monetary fluctuations seriously affect supply and price of Chinese tung on the world markets. An increase in price of over six hundred per cent has been experienced recently in less than a two-year period.

(8) *Superior pressing methods* are employed in the United States, resulting in an oil that is higher in quality than the best Chinese product. Crude native pressing methods in China produce a dark oil with much free acid (5 to 8 per cent). American pressed oil is lighter in color and almost neutral in reaction, and consequently sells at a premium of several cents a pound. Also, American mills extract more oil from the same amount of seed (40 to 44 per cent by weight of the ground tung meal as compared with the 30 to 35 per cent Chinese output). Work on a volatile solvent process of extraction promises to get all the oil from the tung seeds in American mills (the present presses still leave 5 to 6 per cent of the oil in the press cake).

(9) The *ability to expand* tung production in the United States is almost unlimited (within practical limits). Millions of acres of potential tung land now lie idle in the South. In China there is a definite limit to the amount of land available for a non-food crop like tung.

(10) Finally, the American tung producer has inherited the former advantage of the Chinese producer in that he now produces for a *domestic market* that is the largest in the world.

With the above factors in mind, it is perfectly conceivable that the next decade or two will witness the rise of the American tung oil industry to a position of world supremacy. In fact, this country may change in the not too distant future from the world's largest importer of tung oil to an exporter of that commodity.

OTHER POTENTIAL TUNG PRODUCING CENTERS

In addition to the commercial tung producing countries of China and the United States, there are a score or more centers scattered throughout the world that are actively experimenting to determine the feasibility of local tung production. Most of these are colonial possessions of the larger European powers.

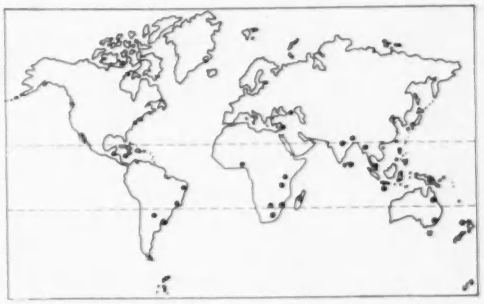

FIGURE 22.—Some major centers of experimental tung tree culture. Experimental work with tung production is being carried on in over a score of countries, in addition to China and the United States. As yet, however, none produces the oil on a commercial scale. Plantings that lie roughly between the Tropics of Cancer and Capricorn (unless in highland areas) are mostly of the tropical species of tung (*Aleurites montana*); groves located outside the above zone are almost invariably of the true tung tree (*Aleurites fordii*).

The most important plantings to date have been carried on in the British Colonies and Dominions (Figure 22). According to recent reports, experimental work is now in progress in New Zealand, Australia, New Guinea, British Malaya, Burma, Ceylon, India, Kenya, Tanganyika, Nyasaland, Rhodesia, Union of South Africa, Nigeria, Palestine, British West Indies, and British Honduras.

Next to the British possessions, interest in tung production has been most pronounced in certain Latin American countries, especially northern Argentina, Paraguay, and eastern Brazil. In addition, trial plantings have been made in other parts of the world, a few of which are those of the Netherland East Indies, Madagascar, Portuguese East Africa, and southern U.S.S.R.

Rather poor results have been achieved with the true tung tree (*Aleurites*

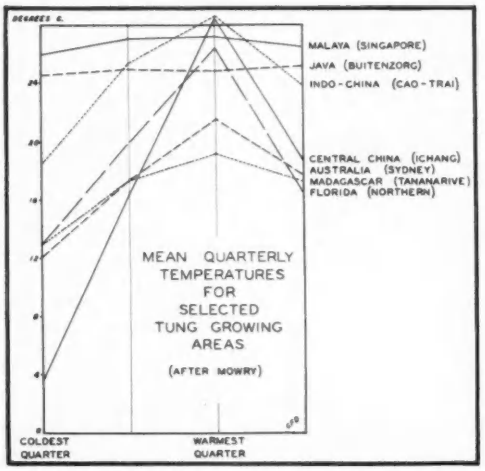

FIGURE 23.—The lower group of four stations possesses the necessary dormant season for the production of the true tung tree (*Aleurites fordii*). The upper group of three stations is typical of those tropical areas that must grow *Aleurites montana* or some other tropical variety. Note the exceptionally low winter temperatures of the tung areas of Central China.

fordii) in the more tropical of these regions, because of lack of the necessary cool dormant season required by such trees. Many tropical centers such as Burma, Java, British Malaya, Borneo, Nigeria, British West Indies, and British Honduras have largely replaced the true tung tree with a closely allied species (*A. montana*) that does not require a dormant season. While the oil from this species is said to be chemically identical with that of *A. fordii*, the oil yield per tree is believed to be lower.

The tung groves of southeastern Brazil, Kenya, Tanganyika, Madagascar, and northern India are located in highland areas and hence, despite the latitude, experience the necessary cool dormant season required by the true tung tree (Figure 23). Those located in Paraguay, Argentina, Rhodesia, Union of South Africa, Australia, New Zealand, and the U.S.S.R. are the latitudinal equivalents of South China and Southern United States, and thus are also planted to *A. fordii*.

While preliminary reports from several of the above foreign countries appear encouraging, and a few have actually begun extracting oil (a company in Calcutta extracted five tons of oil in 1938), none has as yet become a significant producer of tung oil. In general these foreign producers labor under several handicaps not faced by the Chinese and American growers: (1) they lack the advantage of an early start, which has been of such great value to China; (2) they lack the ability to mechanize their industry to the same extent as American growers; and (3) they lack the huge domestic market that is enjoyed by the Chinese and our own producers (European markets for tung oil will undoubtedly grow, however, once a colonial supply of oil becomes assured). However, it is possible that some of these countries may become significant centers of tung oil production in the future.

GEOGRAPHY IN THE CENSUS BUREAU

A. W. von Struve

THE work of the Division of Geography of the United States Bureau of the Census is of a considerably wider value to geographers as a whole than may at first be realized. While the Division does no topographical field mapping, its office compilation, evaluation, and criticism work has a very definite bearing on much that is really important to an analysis of the economic geography of the United States.

Primarily, the Division is a service branch of the Bureau of the Census. It is its job to prepare the innumerable maps which are used to guide enumerators and their supervisors in doing the field work of census taking. It functions as cartographer and chart draftsman for the Census Bureau's publications. It assists in the establishment of special census measurement units such as metropolitan areas and census tracts. It allocates the so-called "transient" schedules which come in to the Bureau as a result of the field work of the enumerators.

But in addition it has several functions which are less of a service nature. It is doing a tremendous work of area determination within the United States, on a scale never before attempted; and it is preparing several original statistical maps and an atlas on the basis of Census data which will have much social, economic and geographical significance when published.

The Division has been housed for several years in a huge factory-like structure in Washington, D. C.,—a building which used to be a garage and storage warehouse for one of the city's large department stores. Here there is ample room for the charting and drafting tables which are required. The Division normally employs approximately 75 draftsmen, cartographers, statisticians and clerical people, but during the period of the last two years of preparation for the Sixteenth Decennial Census of 1940, employment within the Division has reached as high as 700, or nearly ten times the average permanent employment. The mass of work which was done in readying the geographical aspect of the field work nearly passes comprehension. The largest task was of course the preparation of maps for the use of the census enumerators, of which there were over 130,000 in all.

Somewhere in the neighborhood of 122,000 enumerators were employed during April on the Continental population, housing, and agricultural surveys, and around 6,500 other enumerators were assigned to take the production and distribution censuses which took place during the period January to June 1940. These Censuses were those of Business, Manufactures, and Mines and Quarries, together with a portion of the Census of Irrigation and Drainage. Over and above the 128,500 enumerators thus occupied in the major continental censuses, there have been between 2,000 and 3,000 people at work on these surveys in America's outlying possessions—Alaska, Puerto Rico, Hawaii, Guam, The Virgin Islands, American Samoa, and the Canal Zone. And to supervise and manage the work of this army of enumerators, over 1,200 area managers, district supervisors, and assistants in both classifications, were employed.

With very few exceptions, every

individual in this army of census workers had to have a map, or several maps. Enumerators, except for those working within the bounds of clearly defined small incorporated places, each had to have a plat of their districts. The supervisory personnel not only had to have copies of these maps on file, but also had to have special state, county, area, minor civil division, and district maps.

For census purposes, the nation is divided into 105 geographical areas, each one of which must lie entirely within the bounds of one state. These areas are in turn subdivided into a number of supervisors' districts—528 for the continental United States as a whole. Neither of these figures includes the areas or the districts for United States possessions, which amount to but a handful more in each classification. Finally, these districts are further subdivided into more than 147,000 individual enumeration districts.

The total number of original maps made for the use of the census takers and their supervisors cannot be exactly ascertained. That there were something over 175,000 such original maps made is known. Certainly, this must be the most enormous map-production job in the world!

The Census Bureau does not, as stated before, do field mapping. Its map work is the work of office compilation from previously existing geographical data. Most important of the sources drawn upon to prepare the census maps are the following:

1. Several hundred thousand special state, county, and city maps, prepared by the civil governments in question for their own uses, and transmitted to the Census Bureau with permission for it to use the map data. The Census Bureau undoubtedly has one of the largest, most up-to-date, and most accurate collections of city and county maps and map revisions on file in the country.

2. Highway Departments of the states, and the Public Roads Administration in Washington, also contribute numerous maps, and a huge amount of map data, which they have collected for their road-building and repair work.

3. The excellent aeronautical charts, prepared by the Coast and Geodetic Survey of the United States Department of Commerce, are of great assistance to the Census Bureau. Though on too small a scale to be of specific use in the preparation of enumerators' maps, the uniformity of these aeronautical charts, which are complete for the United States on a scale of 1:500,000, is of much assistance to the Division in checking its other map data. They are also extensively used in the special area-determination project of the Division, to be described later.

4. Maps of the General Land Office show accurately township range and section boundaries which may not be found elsewhere. All such data is grist to the Division's map mill.

5. Other basic maps are, of course, those of the Topographical Survey of the United States Geological Survey in the Department of the Interior. When these maps are sufficiently up-to-date, they do the work of nearly all other existing maps, because of their large scale, their uniformity, and their dependable accuracy.

A great deal of this map work is in a sense original. The reason for this is that through a voluminous correspondence with state, county, and municipal authorities, the Geographical Division is constantly getting new boundary and other data not heretofore available, and is incorporating these data in its own maps.

To give an idea of the work involved

in this cartographic project, one should point out that each enumerator's map, in addition to its careful outline and its fully descriptive content, must be colored by hand to mark the outside boundaries of the district. County maps, for supervisors or for managers, must be colored in five or more crayon colors to distinguish between minor civil divisions, incorporated places, wards, delimited unincorporated places, and national parks and other civil or political boundaries.

The simple task of map detailing, drawing, and coloring is thus seen to be enormous. It is, indeed, by far the largest task the Geographical Division must cope with. But it is not the only one. There are others of equal importance and from the point of view of the geographer, of even greater value. Before getting into that part of the Division's work, however, it would be well to complete the discussion of the strictly intra-Bureau work which the Division does. In its function as cartographer and chartist to the Bureau, it prepares all the charts, all the statistical pictograms, and all the illustrative maps used in the publications of the Census Bureau. This work however, is not so seriously concentrated in character as is that of the map work, partly because there is less of it, and partly because the Division has more time at its disposal to complete the particular task.

The allocation of non-resident or absent household Census schedules is another extremely important and exacting job which the Division has to cope with. What happens is this. In the field, the Census enumerator discovers an individual who is traveling, away from home. This person cannot be censused in a vacuum. It is estimated that there are in the neighborhood of 500,000 such transient schedules during the 1940 Census. According to instruction such individuals should be checked with their home enumeration, to make sure that they are not on the records twice or that they are properly allocated to their place of residence. It is the job of the Geographical Division to do this checking.

It may seem a simple job. But anyone who has tried to cope with census returns from over 132,000,000 people can realize that the location of one simple specific and unique census return out of that monstrous number makes the job of hunting a needle in a haystack seem like child's play. As a matter of fact, so efficient is the tabulating and filing system of the Census Bureau that these transient schedules can be matched with the family schedule of the individual with a minimum of waste effort. Nevertheless the job is one which takes weeks to complete, and, routine though it may seem, is an absolute necessity if an accurate census is to result.

On a broader scale, the work of the Division embraces two major types of undertaking. One involves the development of new and better tabulation areas, valuable both for their permanence as a geographical boundary, and for their definitiveness as socio-economic population units. This work includes the establishment of *metropolitan areas*, and the supervision and criticism of the *Census tract* layouts of large cities.

A metropolitan area is, quite simply, a city by geographico-economic boundary rather than political boundary. Of enormous value to business and industry, as affording scientific market measurements for a given semi-self-contained economic urban unit, these metropolitan areas are established by the Geographical Division, upon recommendations made by an independent, scientific committee of population experts outside the Census Bureau. The metropolitan area as an

economic concept, as opposed to the city as a political concept, has proven to be of value not only to marketing agencies, but also, and even more important, to the cities themselves, their planning, regulating, and welfare departments, and to state and federal governments in their assistance programs for the cities in question.

The census tract idea, first put into practice in a few cities 30 years ago, was promoted by the Census Bureau to try and work out a method of establishing permanent non-political boundaries inside of large cities. The election district, ward, school district, and so on are in most cities political in origin. They are subject to change with any change of political temper. While this may have no ill effects upon the city's inhabitants or even upon its government, it does have a serious disadvantage for the Census Bureau and for other public and private agencies interested in obtaining accurate and chronologically constant areas for the tabulation of economic and social data. The Division of Geography exercises only a supervisory function in the setting up of these tracts. It has established optimum requirements, with stated minimums and maximums of population which should be included in each tract, and with certain simple requirements for clarity of boundary for every tract; but the tracts themselves are decided upon by public or private agencies in the cities themselves. As of April, 1940, 71 cities have established census tract grids for their own areas.

Census information is published in certain classifications of data for all metropolitan areas, but the data for census tracts is not published, and is available for the use of each city only upon payment of the small costs involved in tabulating the material desired by tracts.

The second research type of activity which the Division of Geography undertakes has to do with technical studies in the field of statistics and geography. Much of this material partakes of a sort of intramural nature, inasmuch as it is in the first instance only of use to the Division and to the Census Bureau. Yet most of the classifications of special work have a much broader significance than simply the improvement of census techniques and tables.

The Division is, for instance, conducting a research project in methods of showing statistics on maps. Though this work is meant primarily to improve the Division's own publications, it is obvious that any improvements worked out will be of value to cartographers and visual statisticians as a class. The same thing holds for the Division's theoretical research into sampling methods. It has under way a project whereby through analysis an optimum method of dwelling-unit sampling may be worked out. The Bureau is one of the largest practitioners of sampling in the country, and the results of its experimental work in improving the accuracy of the technique will first be of value in its own activities. Obviously, however, these refinements are public property, and will be available to all who may wish to use them.

The Division also has under way an economico-geographic analysis of America by which it hopes to develop a standard layout of statistical areas for Census work. And finally, it is conducting a huge study, both in the office and in the field, the end-product of which is to be the establishment of notable distinctions to be made between rural and urban occupance. Geographers are familiar with the problem. How can one classify people living in some of the innumerable areas of the United States which contain characteristics both of the urban habitat

and of the rural? The urban-farm and the rural-nonfarm classifications, both first worked out by the Census, were results of this type of research, and what is now going on is a continual refinement and extension of the study of the problem.

There are, for instance, over 20,000 unincorporated places in the United States. These communities are estimated to contain well over 10,000,000 people. Most of these places have never been demarcated, bounded, or accurately described. It is one of the major functions of this particular project within the Geographical Division to delimit these unincorporated places, and during the past year or so approximately 2,000 of them, in 30 states, with the assistance of State Highway Departments have been so bounded. Although this work is of first interest to the Census Bureau, since it makes the establishment of enumeration districts for census takers much easier, it obviously has a wide and varied value to business and industry and to state and county governments. The latter are, of course, coöperating largely in the doing of the work.

In addition to these several undertakings of the Geographical Division which have primary value inside the Census Bureau itself, there are several other projects under way which are mostly for public use. One of the most elaborate of these is the determination of county, minor civil division and other small areas within the United States.

Geographically considered, the actual land-and-water area of the country by the minor civil divisions of counties has never been accurately reported. The basic measurement of the continental area of the United States was published in 1881 by Henry Gannett, geographer for the Census of 1880. Gannett, using the best available maps, and the calculated areas of quadrilaterals of longitude and latitude was able to produce an area figure for the United States which is highly accurate to this day—although such as the land-and-water area involved in such sections of the country as Chesapeake Bay, the United States portions of the Great Lakes, Long Island Sound, and so on, were not included.

While the Gannett figure for the United States is fairly accurate as to area, and likewise his computations of state areas, the county and smaller surveys of the time are of little value today. The reason for this is that the boundaries of numerous counties have changed and new maps based on recent surveys have rendered the old maps obsolete.

Now since those days the maps of states and counties have improved greatly. Much more accurate local surveying has been done, and as a result even the county maps today have a high percentage of accuracy for most of the United States. County area measurements too have been brought up to date. But the areas of the some 55,000 minor civil divisions of which the country is compounded are not known with any accuracy at all. This measurement the Geographical Division now has under way—as before, by planimeter or linear scaling or other method of map measurement. But today's maps are so improved that figures of real value can be obtained by these methods. The splendid aeronautical charts of the Coast and Geodetic Survey, which present the United States on a scale of 1:500,000, are being used as base maps, and using them as a control the minor civil divisions and other area units of the country are being measured from the best available detailed maps, and their areas adjusted to known state areas.

The result will be, as suggested before, a slightly more accurate figure for the land-and-water area of the nation, and of course new and much improved data on the areas of the smallest subdivisions of each state and county.

It is perfectly true that the measurements possible today will at best be only a close approach to complete accuracy for the nation as a whole. As long as the Topographical Survey project of the United States Geological Survey is forced to proceed at snail's pace through lack of funds, American geographical data will lag far behind those of other countries. Someone has estimated that at the present rate, it would take about sixty years for the Topographical project to be finished. New hope is held forth by improved methods of aerial photography. Only a national program backed by $150,000,000 is lacking.

The Geographical Division is, then, doing what it can with the materials at hand concerning this area measurement project. And it is a worthwhile task it is doing, too: for even if the areas of the minor civil divisions are known only as a percentage of a known whole, in this case of state areas determined from quadrilaterals of latitude and longitude, still this will be a real forward step. Geographers will have tables of sufficient accuracy for their purposes, and the various interested divisions of state and county governments, and the Federal Government as well—highway departments, utility departments, planning bodies, sanitation bodies, and the like—will all have at hand some area data which has long been badly needed. Revisions and remeasurements of course will be made for each Census.

There are two final projects within the Geographical Division which will be of wide public interest when they are completed. These are the preparation of a national population density map and the publication of a statistical atlas.

The density map, which will probably be on a scale of 1:2,500,000, will contain color shadings by minor civil divisions of the population density for the country, and in addition much other valuable cultural data.

The statistical atlas, which will be the first published since 1924, will, it is hoped, contain a comprehensive picture of the United States as compiled for the 1940 censuses, interpreted *geographically*. This volume will contain much that is new in the way of presenting statistical data geographically, and may well fill what economists, statisticians, and sociologists of all types have long felt should be a census contribution.

The two latter projects await not only the completion of the 1940 Censuses and of several of the subsidiary research projects already described, but also the final authorization of their preparation and the financing thereof. It is to be hoped that the very great importance of these two basic publications in the field of economic geography will be realized, and that this volume and population density map will appear in due season.

A DRY-FARM REGION IN UTAH

Norah E. Zink

THE Levan Ridge in Juab County is located almost in the center of the state of Utah. This small dry-farm area lies in the southern part of Juab Valley, occupying most of the land between the towns of Nephi and Levan which are approximately eleven miles apart (Figure 1).

Levan Ridge

In structure the Levan Ridge is an alluvial fan, or more correctly a series of alluvial fans which coalesce. In area it is about six miles long and from three and a half to four miles wide, embracing roughly twenty-four sections of land or approximately 15,000 acres. The highest part of the fan, the center at the east, has an altitude of 5,800 feet. From here it slopes gently to the west, north, and south. The north end, its lowest part, is 5,100 feet in altitude. Of the 15,007 acres on the Ridge, 13,464 acres are being dry-farmed. Because of rocky and sandy soil, or rough topography, most of the remaining land is classified as "other" or grazing land.

Today this is the best known dry-farm region in Utah. This is due, for the most part, to the fact that a dry-farm experimental station has been maintained there continuously since 1903. Because of this farm, practices on the Ridge are uniform and progressive. In addition, it is a small compact area, located on a main line railroad connecting the region with a seaboard market. Neighboring counties furnish smaller local markets. Natural factors, too, in the form of deep clay loam soil and rainfall sufficient for dry-farming have aided in making the Levan Ridge outstanding.

This dry-farm region is favored in many ways. Not only are the physical conditions conducive to raising crops without irrigation but many cultural factors also are favorable. The most important consideration in dry-farming is the amount of moisture available for plant use. Therefore, the chief requirements necessary to carry on dry-farming are proper amount of rainfall and deep soil with large water-storage capacity. The generalization is often made that dry-farming should not be attempted in Utah where the average rainfall for the year is below 12 inches. The average on Levan Ridge for 35 years, as recorded at the station on top of the Ridge, is 12.75 inches, 48 per cent of which falls in the first five months of the year. Other months of relatively heavy rainfall are August and October. For winter wheat there are two periods when moisture is especially necessary, in the fall at planting time, and in the spring when the plant is making its vegetative growth. The average rainfall on the Ridge and its normal distribution with a spring maximum and moderate rain in the fall are fairly well adapted to the production of this crop. In common with other semi-arid regions, however, this district suffers from wide fluctuations both in amount of rain and in its distribution. As a result there are great differences in yield from year to year. Records for 26 years kept at the experiment station show yields of wheat ranging from 5 to 42 bushels per acre. However, not

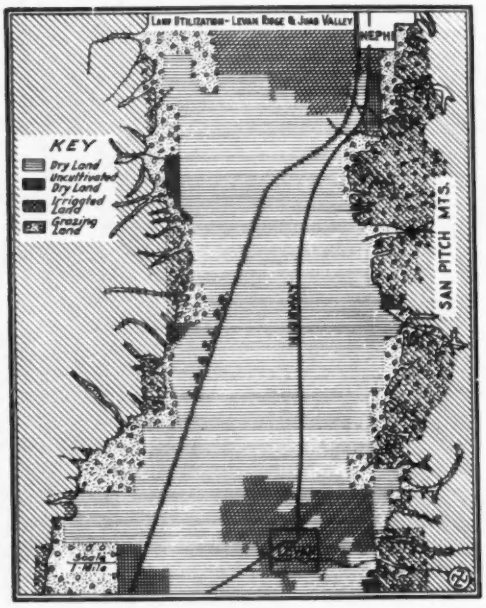

FIGURE 1.—Irrigated fields immediately adjoin the towns of Nephi and Levan. Dry-farms fill the remainder of the intervening area, bordered by the higher sagebrush grazing lands on both sides of the valley.

all of this variation in yield is due to rainfall. The low yield of five bushels per acre was largely the result of loss of spring run-off, due to the fact that the ground was frozen in the fall when the snow fell and remained frozen throughout the winter. Other climatic factors are also important, such as: evaporation, April temperatures, winter snow-covering, amount of run-off, and date of last spring frosts. In general, however, climatic conditions on the Levan Ridge are adapted to the production of dry-land wheat. Most of the Ridge has a very deep clay-loam soil. Of particular significance is the fact that the soil carries a substratum of rather heavy blue clay which has an exceptionally high moisture-holding capacity. These soils contain sufficient amounts of phosphorus and potassium, but, like all arid soils, they contain little nitrogen. By observing the fallow year, adding organic material in the form of straw, and furnishing better moisture conditions, the amount of nitrogen in them is being increased slightly.

A very important advantage which the Levan Ridge possesses is good transportation facilities. The former main line of the Los Angeles and Salt Lake Railroad, which is still used for regular freight and passenger traffic, crosses the Ridge itself and connects Nephi with Salt Lake City and Los Angeles. This has made possible the shipment of wheat direct from the Ridge to southern California. United States Highway No. 91, a paved road and the route most commonly used between Salt Lake City and Los Angeles, also crosses the Ridge. Other highways afford access to towns east and west of Nephi.

MARKETS

Two types of markets are important to wheat growers in Juab County: (1) distant markets, (2) local markets. The basic point upon which the schedule of prices is built for the intermountain region is the locality which demands the wheat. Generally for hard wheat this is California, which has an import price, tending to fluctuate with prices in markets in the East and abroad. Since a large proportion of the wheat imported in California comes from the Pacific Northwest, the price of California wheat moves more closely with that of Portland than it does with that of any other place in the United States. The value at Portland, due to the large volume of white wheat exported from that region, reflects the world wheat price established at Liverpool. This price often determines the amount paid for wheat in Utah.

Wheat from Levan Ridge may move by rail, north to Ogden, or southwest to southern California. The latter is,

however, the natural outlet for wheat from this area and, unless there is a shortage at Ogden, the wheat normally moves direct to California. This is done to avoid paying the freight rate from Nephi to Ogden. In normal years the Ridge used to ship from 40 to 65 carloads of wheat per year to California, which needs hard wheat to mix with its own soft wheat for flour making. Formerly on a surplus wheat basis, California has recently shifted to a deficiency basis. A large percentage of the wheat is used in the immediate locality of Nephi and Levan and in other near-by markets. The

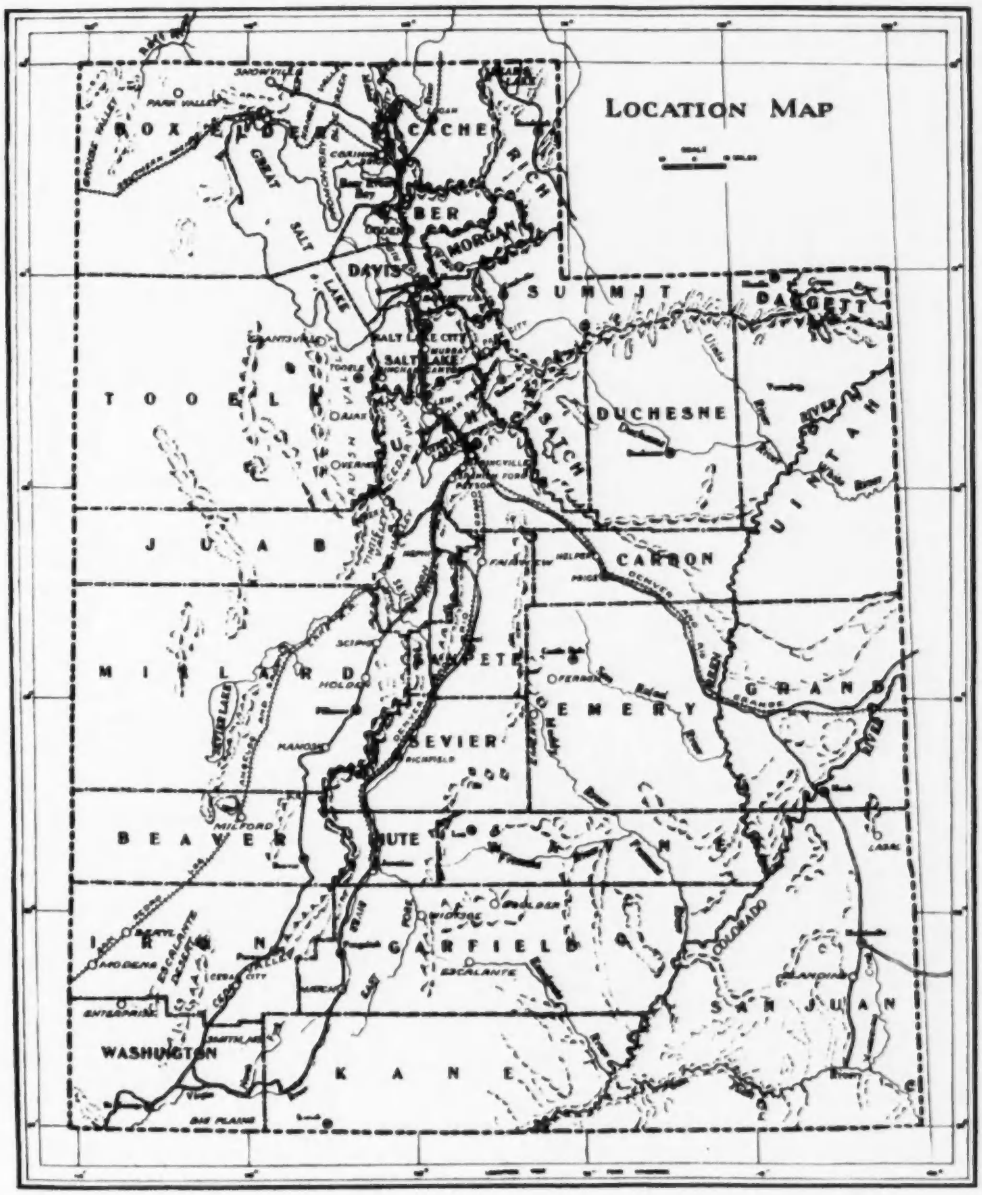

Figure 2.—Relief map of Utah. (Courtesy of the United States Geological Survey.)

FIGURE 3.—Implement shed on the Ridge. Most of the farms on the Ridge have a building for storing implements, and a few farms have sheds large enough to house some of the machinery. With the exception of half a dozen trees at the Experiment Farm, these are the only shade trees on the Ridge. They are irrigated by water pumped from a well.

two mills of the Juab County Mill and Elevator Company in Nephi furnish a local outlet for wheat. Many counties of Utah do not produce wheat enough for their own needs. Others produce more than they need but not always of a kind required by the market. Box Elder, Cache, and Juab counties are large exporters of wheat. Sanpete, Sevier, and other counties export soft wheat but sometimes import hard wheat. Salt Lake, Weber, Davis, and Utah counties all import wheat. Thus Levan Ridge has another local market for its surplus (Figure 2).

A market change has taken place recently, in marketing the Juab wheat. From 1931 to 1933 a yearly average of only 7 cars of wheat has been shipped by rail from the Levan Ridge and neighboring farms. In 1930, 89 cars left this section. Various reasons for this change have been given, among which are: (1) decrease of wheat production in the region due to drought; (2) increased use of trucks in shipping; (3) building of a coöperative warehouse in Nephi by the Farmers National Grain Corporation; and (4) increased local demand. Probably all of these factors have helped to cause decreased shipment of wheat by rail. The average yield per acre for the years 1930–1932 was about 16 bushels. (From figures in reports of farmers to the Wheat Allotment Committee for Juab County.) It has been estimated that 22 bushels per acre were average for the Ridge preceding the drought period. The difference in production between these years and normal years was approximately 35,500 bushels or 24 carloads. Decrease in wheat production alone does not account for the large difference in the number of cars shipped in 1930 and those shipped in the succeeding three years.

Shipping wheat by trucks instead of by rail has become a common practice in all parts of the state. This method of transportation has two advantages; first, the farmer himself can do the hauling during the late fall and winter months, when he is not otherwise employed, and thus can save the freight rate, and second, he can hold his wheat until the price is higher. Farmers throughout the state have been greatly interested in storing their wheat and waiting for an opportune time to sell. The practice of holding wheat on the farm is not always profitable, but in 1932–1933 this holding policy paid the farmer.

LOCATION OF HOMES OF RIDGE LAND OWNERS

Granaries and implement sheds are scattered over the Ridge but there are only eight houses (Figure 3). All of these are located at the east edge near Four Mile Creek which, quite largely, built the alluvial fan forming the Ridge and from which small amounts of irrigation water are diverted to near-by fields. Formerly permanent homes, at present these houses are occupied only during the summer.

Due to the presence of irrigation water, the entire aspect is changed. Fields are small, alfalfa, fruit, and corn are raised, and houses, barns, and trees are in evidence. The landscape has changed from that of the dry-lands to one typical of an irrigated area.

On the Ridge there are nine wells ranging from 100 to 240 feet deep most of which are run by windmills. Some of the well owners need water for cattle which are kept in the fields part of the year (Figure 4). An attempt is being made to raise apples on top of the Ridge and the owner expects to install an engine in his well there to pump water for irrigation purposes. Many attempts at raising fruit trees on dry farms have been made; some of them proving successful in the northern part of the state. Fruit trees do well up to a certain stage of growth, but after that, unless water is provided, their success is questionable. Before these wells were dug, all water was hauled from Nephi or Four Mile Creek, and even today much of the water used on the Ridge is still so obtained.

Figure 4.—Windmill at the northwest end of the Ridge. Horses and cattle are kept here during the winter. The low hills which border the Levan Ridge on the west are seen in the background.

The owners of the Ridge lands for the most part live in Nephi and Levan, which lie immediately north and south of the dry-farms (Figure 5). In 1930 these small agricultural towns had populations of 2,987 and 611 respectively. Within the towns each householder owns a city lot, large enough to include a garden and fruit trees. The irrigated fields lie southwest, west, and north of the towns. Here hay, grain, and native wild grass are grown. Within the towns themselves are several apple orchards which furnish fruit for shipment.

Land Units

Dry-farming, with its comparatively low yields and half its land idle each year, is usually associated with the thought of extensive holdings and large fields, yet this is hardly true on Levan Ridge. The 15,007 acres of land I have designated as the Ridge are divided into 156 parcels of land held in the name of 122 people or groups of people. The average size of the separate fields is 96 acres and the average number of acres owned by each person is 123. The land is actually controlled by only 109 groups because of combination ownerships within families and the average number of acres owned per family is 137. In general terms, one-fourth of the farmers own on the Ridge 40 acres or less, over half of them own

80 acres or less, and three-fourths of them own 160 acres or less.

When it was found possible to produce wheat commercially upon the Ridge, residents of Nephi hastened to secure land. Some of these people already owned irrigated lands near the town and homesteaded or bought drylands because dry-farm practices fitted in well with their other farm labor and at the same time permitted further use of horses and machinery already owned. Others secured land on the Ridge because they considered this type of farming simpler and easier than irrigated farming, which required more nearly constant work. The land as now owned was obtained in one of four ways, (1) by homesteading, (2) by buying from the state, (3) by buying from an individual, and (4) by inheritance. Only about 15 per cent of the land was homesteaded. The remainder was at one time or another bought from the state, much of it at $1.25 per acre but some at a price of $2.50 to which the State Land Board raised the price in 1906.

FIGURE 5.—A home in Nephi of a farmer who owns land on the Ridge. This bungalow is typical of the homes of dry-farmers who live in towns. In the foreground is an irrigation canal.

Assessed values of dry-land on the Ridge range from about $5.00 an acre to $25.00 an acre. Since the assessed value of this dry land is about 60 per cent of the selling price, probable real values in 1932 ranged from $7.50 to $30.00 per acre. Good irrigated land was assessed at $100.00 or about three times the value of good dry-lands. Prices paid for some of the land, however, were very much higher than assessed values, especially during the years 1926 to 1930 and reached as high as $75.00 an acre for a small tract, and $65.00 and $55.00 an acre for larger ones. Land values are closely related both to soil types and yields. Grade A land occupies dark clay loam on the top of the Ridge, poorer grades are found on gravelly rocky loam along the hill sides, and on the heavy white clay at both the north and south ends of the Ridge. Land lowest in value lies at the southwest edge and is subject to late spring frosts. Most of the land of highest value produced an average of 18 bushels or more per acre for the years 1930–32, and most of the lower grades, less than 14 bushels per acre (Figure 6).

FARM PRACTICES

The presence of the Experiment Station in the region has greatly affected farm procedures, resulting in the use of improved methods by these farmers and nearly identical practices. This uniformity in the working habits may be due also, in part, to the small size and the compactness of the region and to the lack of variations in natural conditions. Soil, relief, altitude, and weather factors remain nearly constant throughout the area. As would be expected these farming operations are those set forth by the experiment workers as the "best practices" to obtain high yields at as low a cost of production as is possible.

The amount of land worked as a unit is not always the exact acreage

owned by an individual or family. In some families, brothers work the land together, or a son or other relative may operate land in connection with his own. In other cases where the owner does not live in the vicinity or is a woman, the land is leased to an operating farmer. The common procedure is to lease it on shares, the worker usually receiving two-fifths of the crop. In all there are 70 different working units on the Ridge, averaging 232 acres each. About one-third of the working groups manage 100 to 160 acres, another

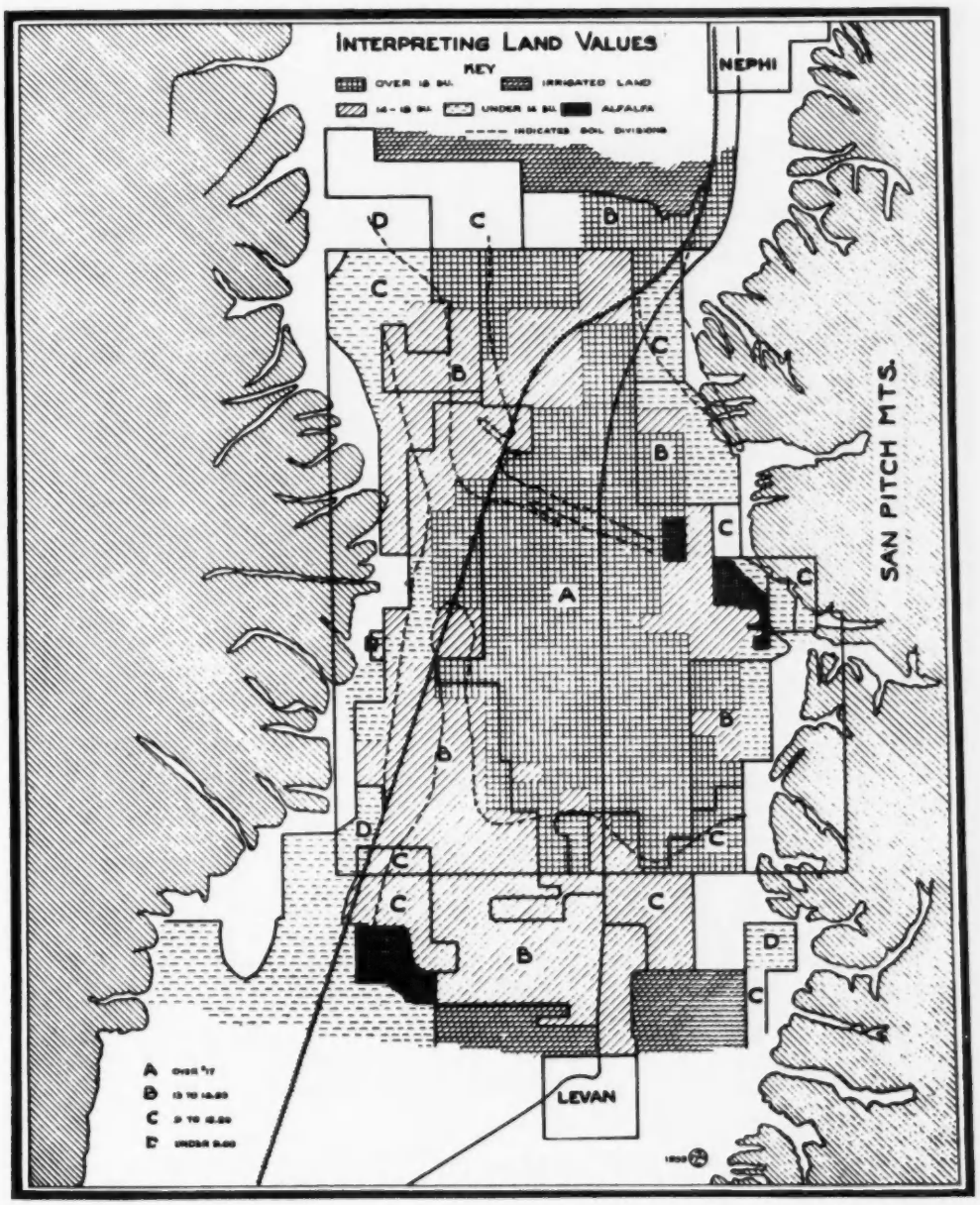

FIGURE 6.—A combination of the soil, yield, and assessed land values maps. It shows that the highest priced lands are those having the best soil and highest yields.

third work more than 160 acres, and the remainder farm less than 100 acres. Therefore, while the average amount of land owned by an individual or family may be rather small, the actual working units are a size more suited to dry farming. (O. E. Baker, "A Graphic Summary of American Agriculture," *United States Department of Agriculture Yearbook*, 1921 [Washington: Government Printing Office, 1922], p. 414: "In the dry-farming areas half sections of land [320 acres] and sections [640 acres] are the normal-sized farms.")

FIGURE 7.—Some of the best land on the Ridge. The land appears nearly level to the eye. Planting usually begins about the middle of September.

The majority of owners plant approximately half their land each year. Where the acreage is small, however, and especially where work on it is part of a larger work program, either because the land is leased or because the farmer owns dry-land not on the Ridge, all the land may be planted one year and all lie fallow the next year.

Twenty-four tractors and sixteen combines are owned by Ridge operators. The men owning both tractors and combines also own, or work, more than 200 acres of land (Figure 7). Horses are still used and those farmers, who do not own combines, hire this work done. In a survey of the Levan Ridge made in 1929 by the Agricultural College at Logan, Utah, the large investment in machinery of the Juab dry-farmers was found outstanding. This report recommended that if a farmer cultivated but 200 acres or less, he should buy machinery in coöperation with other owners of similar amounts.

Numerous granaries for storing wheat are found on the Ridge, or on the home lots in Nephi. They are made of sheet-iron, circular in shape, some 10 or 12 feet high, and hold from 2,000 to 3,000 bushels of either loose or sacked grain. These granaries formerly were used more extensively than now, because in 1930 the Farmers National Warehouse was built in Nephi and since that time many of the farmers store there. In addition to private granaries and the warehouse, much grain is stored, at least for short periods of time, in an unbonded elevator on the Ridge, and in the two mills in Nephi. In 1932 about 45 per cent of the farmers stored grain in their own granaries, 21 per cent in the warehouse, 26 per cent in the mill, and 7 per cent either in the mill or warehouse.

An important factor in selling hard winter wheat is the protein content.

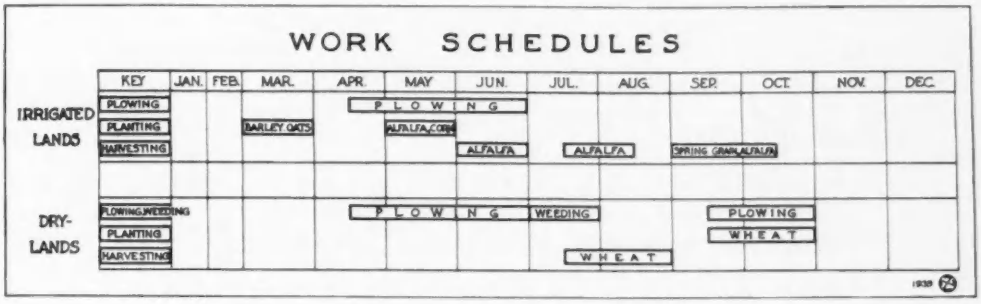

Figure 8.—Work schedules on dry-farms and irrigated farms.

Dry-farm grains in Utah are characterized by a low moisture content and a high protein content. This content varies from year to year and from one place to another. At times premiums as high as five or six cents for one per cent gain in protein are paid. The top of Levan Ridge sometimes averages only nine or ten per cent, although the lower lands always average more. In 1932 much of the Ridge averaged 14 per cent protein. The basis for payment that year was 13 per cent.

Relation of Dry-Farming to Irrigation

Farming of dry-lands in Utah is somewhat closely related to farming of irrigated lands. The practicability of farming both types of land was advocated by the United States Bureau of Reclamation. F. H. Newell, in "Irrigation and Dry-Farming," *Deseret Farmer*, Salt Lake City, Utah—February 11, 1911, said: "The best condition for success in the arid regions is one where a small acreage on each farm can be irrigated and intensely cultivated and where a variety of crops, especially those consumed on the farm and in the home can be raised. This small area even if no more than a good-sized garden patch, is the citadel of the home. . . . Outside this area there may be a hundred or several hundred acres under cultivation by arid agriculture without the artificial application of water. This larger tract of dry land may yield a generous living, . . . Here on the dry-lands is where the larger profits may be made with a relatively small investment. It is this combination of irrigation land with larger acres of dry-lands on which there is an intelligent application of dry-farming principles which has enabled hundreds of farmers to succeed while their neighbors depending upon one crop and trying to utilize all the dry land every year have failed miserably."

As shown by the diagram, Figure 8, the two types of farming can be carried on simultaneously and a greater use can thus be made of horses and machinery. Only at two periods during the year is there likely to be a demand for work on both the dry-farm and irrigated land. These occur at the second and third cuttings of alfalfa; the farmer then may be crowded for time and additional help is necessary. In spite of the advantages of owning both types of land, only half of the owners of dry-land on the Ridge also possess irrigated land. Fifty-four of the Ridge farmers own 1,266 acres of land with water rights or an average of 23.4 acres each. The largest number of men owning both types of land are men who own less than 320 acres of dry-land, and most of the irrigated

land (85.9 per cent) is owned by these same men. However, the average size of irrigated holdings generally decreases as dry-land possessions become smaller.

The type of crops raised on irrigated land in this section is the result of several factors, chief among them being: (1) the small amount of water available; (2) distance from a truck-garden market; (3) proximity to grazing land. These factors have helped to make raising of cattle, sheep, dairy cows, and poultry more profitable than truck gardens or orchards and as a result irrigated lands are devoted almost entirely to supplementary forage crops.

SCALE OF PRODUCTION

An attempt has been made to classify holdings according to the scale of production carried on. Since no definite agreement on a basis for classifying farmers has been reached by economists, ownership of a definite number of animals or acres has been used as a means of classification, and the following basis has been employed: 2,000 sheep, 50 head of cattle, 20 dairy cows, and 100 acres of dry land. (These units were chosen arbitrarily but they include few, if any, non-commercial producers, although they may not include small-scale commercial farms.) Using such a scale, 40 or nearly half the owners of land on the Ridge were commercial wheat producers. Almost the same proportion holds true in owning irrigated lands. It might be thought that the irrigated land would be owned by the smallest dry-land owners. However, this is not the case. Fifty-six per cent of the commercial producers own 68 per cent of the irrigated land. These proportions show that the irrigated land is not owned by the smaller dry-farm owners. This indicates the close relation between the two types of farming.

Products, other than wheat, raised commercially by these farmers are sheep and wool, cattle, eggs and honey. Poultry-raising is the most popular supplementary source of income, five farmers producing eggs on a commercial scale, and many others owning large farm flocks. White leghorns predominate, and for the most part the eggs are sold to the Utah Poultry Association for distribution in New York City. Usually cattle are shipped to Los Angeles, sheep and lambs to Denver or Kansas City, and wool to Ogden and Boston. In addition to farming, some owners have other work. Those who neither work nor raise supplementary crops are women or elderly people. Only seven men own no irrigated land but devote all their energies to dry-farming, working their own land, leased land, or doing custom work for others. Thus but 8.4 per cent of the owners of Ridge land pursue only dry-farming; 35.5 per cent farm the dry-lands as part of a general farm program; 8.4 per cent also operate a stock-raising unit or produce on a large scale another crop, such as eggs, cream, honey, or hay; 26.1 per cent have other work; 6.7 per cent work Ridge land with other land; and 14.9 per cent have no other occupation.

The Levan Ridge is an especially interesting dry-farm region to study in detail because it has both large-scale cash-grain farms which are found in all the important Utah dry-farm areas and also dry-farms run in conjunction with irrigated farms and livestock rearing. This second type of dry-farm is the usual one in Utah.

SAN ANTONIO, TEXAS

William T. Chambers

SINCE colonial times San Antonio has held a position of leadership and power in Texas and the Southwest. When Spanish explorers first entered the area an Indian village was centered about the springs at what is now San Pedro Park in the north central part of the city. Spanish efforts to colonize and develop the Texas region were centered at San Antonio. Several missions which sought to Christianize and civilize the Indians were located in that vicinity. A garrison was maintained at the fort named Presidio de San Antonio de Bexar, and the villa or town of San Antonio developed in the shelter thus provided. During the period of Spanish and Mexican rule San Antonio was the principal town in Texas. It served as provincial capitol, and was the chief center of military, commercial, and social activities. After the Americans gained control of Texas the function of state government was lost, but San Antonio remained the largest Texas city until after the census of 1920. She is now the one great urban center of a vast section in the southern and southwestern part of the state.

FIGURE 1.—The San Jose mission dates from 1720. At this and four other San Antonio missions pious Spaniards labored to Christianize and civilize the Indians of that section. What Anglo-American center contains such convincing evidence of solicitude for the well being of native American peoples? (Courtesy of San Antonio Chamber of Commerce.)

ADVANTAGES FOR EARLY SETTLEMENT

The San Antonio area possessed several advantages for early colonization. The small plain, nestled among gray colored chalk hills at the head of San Antonio River, was relatively easy to clear and bring under cultivation. Its black clay soil was quite fertile, and when rainfall was deficient water from the San Pedro and San Antonio springs could be used for irrigation. These large springs issue from fissures along a fault line at the foot of a range of chalk hills in the northern part of the present city. Their copious flow of pure cool water comes by subterranean drainage from Edwards Plateau, and maintains the steady flow of San Antonio River in this sub-humid section. Since San Antonio is in a prairie region, grazing land was abundant there, so that cattle, horses, sheep, and goats could readily be raised to the great advantage of the population. Both fish and wild game were abundant. Timber for use in construction could be obtained from the groves of oak, walnut, elm, and pecan which grew along the river, while the mesquite trees of the prairie made good fuel. Moreover, there were outcrops of limestone suitable for use in building and in the making of lime that was needed in preparing mortar.

The natural strength of San Antonio from a military point of view was an important advantage in colonial times.

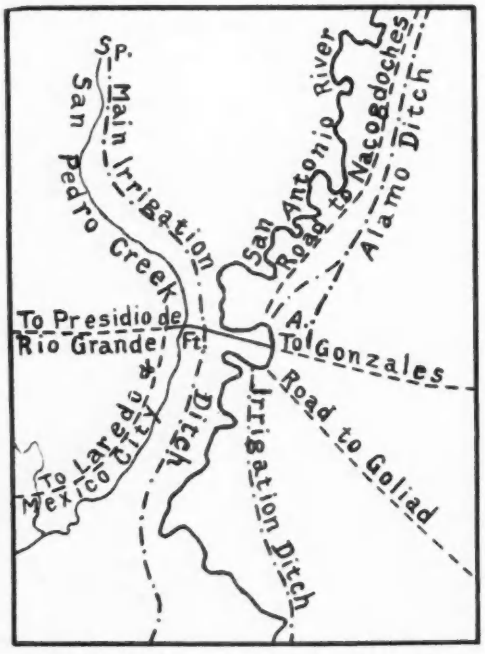

FIGURE 2.—San Antonio de Bexar (early San Antonio) showing irrigation ditches and the rude roads of that time focusing upon the highly defensible hatchet-shaped meander about which the city has grown. Ft.—Fort named Presidio de San Antonio de Bexar. A.—The Alamo Mission. Sp.—San Pedro Springs at the head of San Pedro Creek. (Compiled by the author.)

Location about two hundred miles inland from the Gulf of Mexico and more than twice that distance from the French settlements in Louisiana tended to shelter the place from attack by Europeans. An overland route to the Rio Grande and Mexico City facilitated the support of this remote outpost of Spanish civilization and power. The prairie landscape and clear air characteristic of the San Antonio area gave excellent visibility so that the advance of hostile forces could usually be detected hours before they reached the town. This would allow the colony time in which to marshall its forces and put its defenses in order. The military strength of the place was also buttressed by its local sources of such essential supplies as water, food, and fuel.

Moreover, an axe-shaped eastward bending meander or loop in San Antonio River made the place highly defensible. This meander is somewhat intrenched, and therefore has rather high steep banks which combined with the constant flow of the spring-fed river to form an effective military barrier. When a presidio or fort was built to dominate the narrow land approach to this meander area, San Antonio became the great stronghold of the Texas region. There a garrison was maintained to shelter the colonists and hold the section for Spain. Beside the fort a palace was constructed from which Spanish officials ruled the province. Colonists came from Spain, the Canary Islands, and Mexico, while the missions attracted recruits from the Indian tribes of that section. As San Antonio grew, farmers and ranchmen occupied the surrounding land, commercial and political activity increased, and the position of the town as the leading center in Texas was strengthened.

SUSTAINED GROWTH

Having the advantage of an early start, San Antonio has grown steadily and rapidly. In 1850, the first census year after Texas was annexed by the United States, San Antonio had 3,488 inhabitants, but by 1930, only eighty years later, the population of the city numbered 231,542. Although this great growth was rather evenly distributed throughout that eighty year period, there were times of both rapid and moderate development. Thus the population increased one hundred thirty-six per cent between 1850 and 1860, a period of rapid American migration to the vast new lands of Texas. The rate of growth subsided during the trying times of the Civil War and Reconstruction, and then mounted to eighty-three per cent for the period between 1880 and 1890. Again the growth curve declined during the depression years of the

"nineties" and then advanced to eighty-one per cent for the first decade of the twentieth century. The census reports of 1920 and 1930 show population increases of sixty-seven per cent and forty-three per cent respectively. Since the population of San Antonio is now estimated at 262,000 it is apparently still a growing urban center.

FIGURE 3.—The central portion of San Antonio seen from the south. Note the winding San Antonio River with its numerous bridges, the old but formerly fine residential area to the right, and the large arsenal building on the left. The Smith-Young tower in the center of the picture is the most distinctive office building of the city. (Courtesy of San Antonio Chamber of Commerce.)

TABLE I

GROWTH OF LEADING TEXAS CITIES

Year	*San Antonio*	*Houston*	*Dallas*	*Fort Worth*
1930	231,542	292,352	260,475	163,447
1920	161,379	138,276	158,976	106,482
1910	96,614	78,800	92,104	73,312
1900	53,321	44,633	42,638	26,688
1890	37,672	27,557	38,067	23,076
1880	20,550	16,513	10,358	6,663
1870	12,256	9,382	.....	.....
1860	8,235	4,845	.....	.....
1850	3,488	2,396	.....	.....

STRATEGIC LOCATION

The sustained growth of San Antonio is largely a response to the strategic location of the city at the junction of important natural routes of overland transportation. The city is situated at the inland margin of the Gulf Coastal Plain just outside the curving southeastern rim of Edwards Plateau. The bold eroded face of that plateau along Balcones Escarpment is an effective barrier to railroad and highway construction in a large area which extends northwestward from San Antonio. To avoid this rugged highland barrier great east-west trade routes, which skirt the northern coast of the Gulf of Mexico and extend westward to the Pacific, curve southward through San Antonio, and thence utilize the plain of the Rio Grande Embayment as a pathway to the West. This great east-west route is crossed at San Antonio by another important route which traverses the fertile blackland plain that lies east of Edwards Plateau and connects Dallas, Fort Worth, and land to the north with southern Texas and the northeastern part of Mexico.

This strategic location, together with the political and military importance of the place, caused early roads and trails to focus at San Antonio. When railroads were built in the Southwest, several principal lines were projected through the city, and more recently San Antonio has become the main South Texas junction point of federal and state highways. It is also one of the major air route centers of the Southwest.

COMMERCIAL ACTIVITY

The commercial supremacy of San Antonio in southwestern Texas is unchallenged. Since colonial days it has been the outstanding town of all that section and the people have long been accustomed to purchase supplies there. The highways and railroads of that section converge at San Antonio much like the spokes of a wheel about its hub. This transportation advantage together with the location of the city makes San Antonio readily accessible to the markets of all southwestern Texas. Moreover the magnetic attraction of the large city irresistibly pulls the trade of that section to a focus there.

Thus the large size of the city, its traditional leadership in that region, and superior transportation facilities combine to give San Antonio a dominating position in the commercial life of that section. The city is a market and shipping point for many South Texas products. The list includes petroleum, natural gas, cattle, hides, wool, mohair, early vegetables, citrus fruits, and pecans. Wholesale houses located at San Antonio distribute many kinds of consumers' goods to retail stores throughout southern and southwestern Texas. Thousands of people come from the cities, towns, ranches, and farms of that section to shop at San Antonio. And there is no large city close by to compete for this trade. Since several important railroads and highways radiate from the city into Mexico, much of the trade with that country passes through or originates there.

FIGURE 4.—The Alamo, major shrine of Texas history, where about 185 Americans (Texans) resisted unto death the attack of 3,000 Mexicans under Santa Anna. "Thermopylae had its messenger of death, the Alamo had none." Note the Lone Star Flag of the Republic of Texas and the corner of a modern office building to the left. (Courtesy of the San Antonio Chamber of Commerce.)

MANUFACTURING ACTIVITIES

The regional leadership of San Antonio is as pronounced in manufacturing as in commerce. Indeed it is the only industrial center of importance in southwestern Texas. There are abundant supplies of petroleum and natural gas from producing fields in that section for use as fuel and as a source of power. The labor market is excellent since living costs are moderate and trade-unionism has made relatively little progress there. Almost every grade of labor is available since the population includes many thousands who are of German and Mexican origin as well as Anglo-Americans. Industrial materials produced in the San Antonio section include petroleum, lignite, coal, natural gas, rock-asphalt, clay, granite, gypsum, limestone, cotton, wool, mohair, cattle, hides, skins, cottonseed, vegetables, citrus fruits, and pecans. Moreover the city is well located with respect to markets. Approximately 1,200,000 people live in the San Antonio trade territory, railroads and highways radiating from the city give its factories contact with this area as well as

with more distant sections of the United States and with Mexico, while the neighboring port of Corpus Christi provides an outlet to world markets.

The manufacturing industries of San Antonio are so varied that no one industry dominates the situation. According to the census report of 1930 printing and publishing is the leading industry. Newspapers, periodicals, and books are published, and much job printing is done. The census report of 1930 shows that this industrial group accounted for only fourteen per cent ($3,454,266) of the total value added by manufacturing ($25,067,818). The baking of bread and associated products, foundry and machine shop work, and the making of clothing, particularly women's clothing, are industries of outstanding importance. Other manufacturing activities at San Antonio are slaughtering and meat packing, pecan shelling and processing, and the making of ice, Mexican foods, confectionery, and beverages. It is apparent that San Antonio factories are chiefly engaged in producing consumers' goods for local and regional markets. However, such industries as meat packing, petroleum refining, and pecan shelling and processing are definitely related to regional supplies of raw material. The latter industry employs more wage earners than any other at San Antonio.

FIGURE 5.—Japanese sunken garden, an area of unusual scenic quality, in famous Brackenridge Park at San Antonio. Note the "skyline" of the central part of the city in the right background. (Courtesy of the San Antonio Chamber of Commerce.)

FIGURE 6.—The beautiful Administration Building at Randolph Field major primary flying field of the United States Army. The landing field is a 1,900 acre tract of grassland where, it is said, 300 war planes can "take off" in two minutes. Hundreds of modern buildings house the officers, enlisted men, and cadets who are stationed here. (Courtesy of the San Antonio Chamber of Commerce.)

TOURIST BUSINESS

San Antonio is an important tourist and travel center. Most Texans and many people from other states cherish an occasional visit to the Alamo—famous shrine of Texas history—and to the other old Spanish missions (cathedrals) at San Antonio. The mild sunny weather of winter attracts people from colder climates during that season. People also come to contact the quaint Mexican atmosphere of the city, and to hunt deer on ranches in that section. The city is on the border of the scenic "Hill Country" of southwestern Texas, and the Gulf shore is within convenient motoring distance. Very many tourists come to San Antonio because it is a junction point of highways and railroads which connect the eastern part of United States with California, the Lower Rio Grande Valley, and Mexico.

At San Antonio people believe that recreational facilities and beauty spots contribute to urban prosperity and growth as definitely as do transportation facilities, factories, and business firms. Accordingly, much interest is centered in the creation and maintenance of parks, playgrounds for children, tennis courts, golf courses, swimming pools, and beautiful drives. This type of development is centered in the northern portion of the city where rolling hills, large springs, and clear rushing streams contribute to the attractiveness of the landscape. Here are located San Pedro Park, the famous Brackenridge Park, and the beautiful Olmos Dam parkway which shelters the city from floods. Woodlawn and Elmendorf lakes are other attractive landscape features.

FIGURE 7.—Thomas Jefferson High School at San Antonio, Texas. This fine school plant, located in the northwestern portion of the city, has been acclaimed the most beautiful high school in America. (Courtesy of the San Antonio Chamber of Commerce.)

MILITARY TRAINING

San Antonio is a leading center of military activity. The Federal Government maintains eleven military posts, camps, and aviation fields in the city and its environs. One of these named Fort Sam Houston is in the northeastern portion of the city. It is Headquarters of the 8th Corps Area of the United States Army which includes Texas, Oklahoma, Colorado, New Mexico, southern Arizona, and a portion of Wyoming. The commanding officers of the Corps Area together with Headquarters detachments and contingents of the Infantry, Artillery, Cavalry, Air Corps, Signal Corps, Quartermasters Corps, and other branches of the Service are stationed there. Randolph Field, located a few miles northeast of San Antonio, is described as the "West Point of the Air" because it is the primary training center of the United States Army Air Corps. Advanced training in military aviation is conducted at Kelly Field, in the southwestern portion of the city.

There are several reasons why military training has been centered at San Antonio. The mild dry climate enables military drill, maneuvers, and other outdoor training to proceed at all seasons of the year. These conditions also promote good health and contentment among the troops. Visibility is high in the San Antonio area because clear sunny weather is abundant, and there are no tall trees or high mountains to block one's view. This enables aviators, artillerymen, and other soldiers to see how to do their work well. The proximity of San Antonio to Mexico has fostered military activity there because friction with that country has often caused the concentration of American soldiers along its border. San Antonio also has the advantage of location near the densely populated eastern half of the United States from which most of the soldiers and military supplies are drawn.

EDUCATIONAL LEADERSHIP

San Antonio has more institutions of higher learning than any other Texas city. The importance of the place as a center of Spanish or Latin culture is

attested by the presence there of seven Catholic schools. This group includes St. Mary's University and three other colleges named Incarnate Word, Our Lady of the Lake, and St. Anthony's. Texas Military Institute and St. Mary's Hall are Episcopal institutions, and the University of San Antonio is a Methodist school. The city maintains a public junior college. It is interesting to note that there are two private military schools at San Antonio.

Urban Areas of San Antonio

Like other cities, San Antonio has an array of dissimilar urban areas including a central business district, some industrial zones, and various types of residential neighborhoods. The central business district occupies an area made highly advantageous for the operation of business by the convergence there of principal radiating thoroughfares. It includes that river meander which sheltered the pioneer settlement at San Antonio, and extends to adjoining land upon every side. Shopping activity is greatest upon the principal east-west streets named Houston, Commerce, Travis, and Pecan, but the district extends northward from Nueva Street to Martin and lies between Bowie and Santa Rosa on the east and west respectively.

An industrial or manufacturing zone extends southwestward from the central business section. It is cut by the tracks of the Missouri Pacific, the Southern Pacific, and the Missouri, Kansas, and Texas railroads. Another manufacturing area borders the river and railroad tracks in the south central part of the city. A third industrial district is situated along the Southern Pacific Railroad in the eastern part of San Antonio. Much light manufacturing is done in and about the central business district.

Figure 8.—The river, principal streets, and the generalized cultural pattern of the city. A—Fine residential section. B—Good residential section. C—Poor residential section. D—Very poor residential section. Mfg.—Industrial area. P—San Pedro Park. Sp.—San Antonio Springs, the head of San Antonio River.

The character of San Antonio neighborhoods varies with the suitability of the land and its improvements for residence. The most exclusive residential areas are outside the northern boundary of the city. There, on rolling hills that slope down to Olmos Creek and the head of the river, fine new suburban residential areas are developing. The names applied to various parts of this area—Olmos Park Estates, Parkhill Estates, Alamo Heights, and Terrell Hills—are suggestive of its elevation, beauty, and exclusive quality. Farther southward and inside the city, just west of Brackenridge Park, is an older but very fine residential section known as Laurel Heights. The northwestern section of the city is made up of good residential neighborhoods. With moderately high rolling land, attractive routes to the central business district, and relatively little invasion by business and industry, these areas attract substantial types of people. A similar situation obtains in the Highlands

section which occupies the southeastern corner of the city.

The southern, eastern, and central sections of San Antonio are inferior from a residential point of view. These areas are impaired by railroads, heavy highway traffic, and factories. The central area is further marred by old buildings, apartment houses, proximity to the business section, and the invasion —actual or potential—of business institutions. The "West Side," a poor Mexican section, located between the central business district and the Missouri Pacific Railroad, is the outstanding "slum" of San Antonio. It is an area of unsightly congested dwellings and commercialized vice. Along principal streets there are small shops which sell Mexican foods and staples as well as handicraft and curio products.

Although no longer the largest Texas city, San Antonio is numbered among the outstanding urban centers of the Southwest, and she will probably maintain that position indefinitely. Her population, now numbering about 262,000, is much larger than that of any other southwestern Texas city. Her location at the outstanding railroad and highway focus of that section, together with almost unchallenged urban leadership there, suggests that San Antonio will continue to grow. Her military training activities are sure to expand in this tempestuous age. The powerful urban momentum already attained, as well as those natural advantages which enabled this development, tend to assure the continued prominence of the place.

THE RÔLE OF DEATH VALLEY

R. M. Glendinning

THE human geography of California is essentially a geography of valleys. This is especially so in the humid and subhumid areas and in those parts of the dry areas where irrigation water is, or has been made, available. Scores of such California valleys, large and small, are now utilized because they represent distinctly favorable human habitats and furnish opportunities for a wide variety of human activities. The extensive San Joaquin and the relatively small San Fernando may be cited as example valleys. Death Valley, standing in sharp contrast to the humid or irrigated valleys, has also become a type of utilization area, strangely enough, because of the very factors which render it non-habitable for any considerable number of persons over more than short periods of time. Its very sterility has resulted in its utilization—an arid sterility which, fortunately, is tempered with the alloy of physical grandeur.

Such sterile lands have consistently, either strongly or weakly depending on the degree of moisture deficiency, resisted the existence and spread of human settlements within their confines. In many instances they have acted as very real physical barriers to human movement from one habitable land to another. Some dry lands, virtually tanezrufts, have presented such forbidding conditions that only the most hardy and adventuresome have dared to enter, and then only for a hurried transit. Until recently such areas possessed, if any, but a negative value. At present a few of them have acquired a positive value, a value based, paradoxically enough, on the very bleakness which resulted, not long hence in nearly complete avoidance.

Such is largely the case of Death Valley. Although it is one of the most repellent areas of North America from a settlement standpoint, it nevertheless now annually attracts thousands of persons and hundreds of thousands of dollars. This attractive force has not failed to alter the geographical expression of the valley itself nor has it failed to be reflected in the expression of contiguous areas, especially in the evolution of highways and in services associated with the highway lines and nodes. The rôle of Death Valley, if one may so state it, is and has been so closely related to its basic physical character that at least a general description of its natural milieu is necessary.

Death Valley presents the near epitome of arid conditions. Hundreds of feet of mineral salts in parts of the valley floor attest a long continued, even though spasmodic, desiccation (Figure 1). In a sense, the area is a desert within a desert. Like certain sections of the Libyan hamada within the confines of Sahara, Death Valley approaches tanezruft conditions within the vast sweep of the southern Great Basin, in which it actually lies, and of the nearby Mohave to the south (Figure 2). A conspicuous accompaniment of the aridity, at least on first view, is the apparent sameness of landscape expression throughout the long north-south stretch of the valley; a sameness apparent but not real, for there is an amazing variety of forms which are overshadowed by the synoptic sweep of the initial

observance. Granted that, in larger sense, it is a mountain and bolson desert, yet there are areas of billowing erg, monotonous reg and playa, and intricate networks of wadis.

Because of a central stricture the valley is naturally divided into a northern and southern portion (Figure 3). The narrowing is both tectonic and depositional. Not only is the graben narrower in midportion but great piedmont alluvial fans, aided by the closer juxtaposition of mountain fronts, have thrown a very low dam nearly across the valley floor. The actual floor of the valley is comprised of the nearly flat land of the two major playas (flats, salars) which lie to either side of the central stricture. Invading and partially burying the playas are many alluvial fans, truly tremendous ones on the west and but relatively smaller ones on the east. The apices of the western fans are tucked far up in the deep canyons of the Panamint Range so that they lie as much as 2,000 feet above the lowest spot at, or near, Bad Water (279.528 feet, the lowest point in North America) (Figure 4). The lesser fans of the east, especially along the Black Mountain piedmont, have their apices in lower, less commanding positions. Forming a background for the fans are exceedingly steep, deeply etched, and nearly barren mountain faces which rise to altitudes of from 5,000 to 11,000 feet (Figure 4). The generally barren aspect of playa, fan slope, and mountain wall is modified in only a few sections, and then only on close examination, by scanty xerophytic shrub (halophytic in lower places), as along the "seep-line" of the lower fan aprons, along playa margins, or, in the case of high protected spots in the Panamints, by clumps of trees. Permanent springs and water holes are few and scattered in the lower and hotter reaches but are numerous, though often

FIGURE 1.—Looking south over the southern portion of Death Valley, from a point opposite Bad Water. The white areas represent very heavy concentrations of mineral salts on the valley floor. The network of salt encrusted channels is the work of the so-called Amargosa River. (See Figure 3 for location.)

unmarked and isolated, in the higher sections (Figure 5). Many of the lower ones, as Bad Water, are strongly alkaline. Overlying the forbidding aspect of the graben floor is an uncompromising aridity marked by extreme day and night heat from about early May to later October and by warm to hot days and cool to cold nights the remainder of the year.

The Death Valley trench, generally protected as it is by high rugged moun-

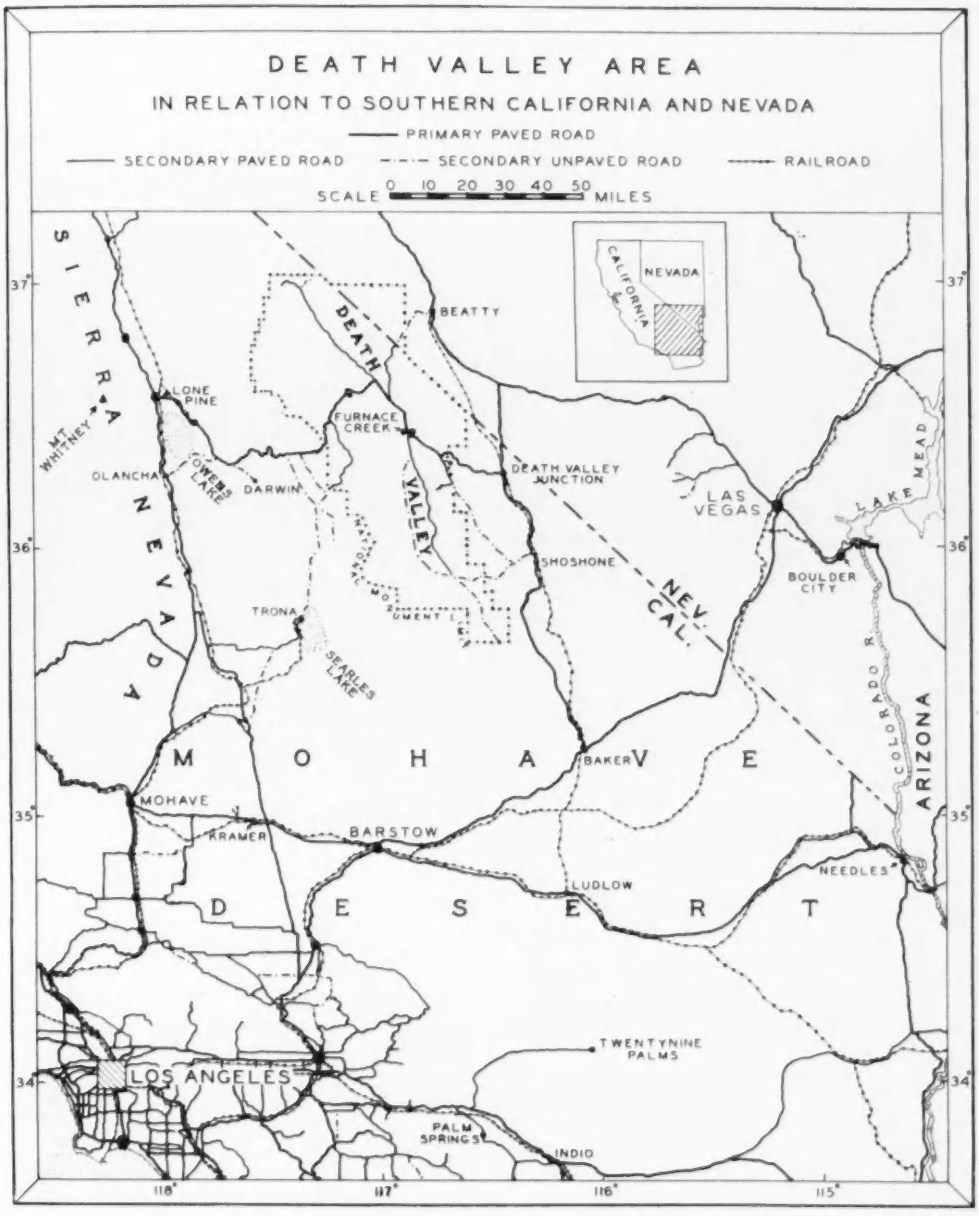

FIGURE 2.—Death Valley, although an integral part of a vast, largely sterile and isolated area, is itself connected with the outside world by modern highways. These connections reflect the recent, yet well established, recreational use of the valley.

tains and by vast dry surrounding territories, can be reached by only certain carefully chosen routes. Of prime importance are the commonly used pass routes of the present, routes which because of their nature or location handle the bulk of the traffic into and out of the valley. The chief of the eastern pass routes are from Death Valley Junction via Furnace Creek (3,042 feet) and from Beatty via Daylight Pass (5,200 feet). The major western route crosses the Panamints at Towne's Pass (5,260 feet). The presence of smooth, hard-surfaced (tarred) roads, as opposed to rough, gravelly, and dusty roads, usually serves as an indicator of the routes' importance. Pass routes of secondary importance enter from the east via Grapevine Canyon, Titus Canyon, Salsberry-Jubilee Passes, and from the southeast via Confidence Mill. On the south and west, similar routes lead in through the Avawatz Mountains, through Wingate Pass, Butte Valley, and Emigrant Canyon. Other pass routes exist but they are essentially trails of little, if any, modern utility. All of the above mentioned routes tie in directly or indirectly with major highways, thus giving access to both near and distant areas (Figures 3 and 5 for routes and passes).

It appears that the first inhabitants of the Death Valley area were the Panamint Indians. Avoiding the summer oven of the valley floor as much as possible this handful of primitive people kept largely to the higher, less parched lands where food was relatively less scarce, although in the winter they moved to the warmer haven of the valley floor. Moving from place to place they garnered a meager living from large and small game, seeds, roots, lizards—in fact anything that could conceivably be eaten. Living as they did they made hardly a scratch on the surface of the Death Valley scene. From them, however, the white man learned, if he were lucky, the location of potable water and the ways into, across, or around the then no-mans-land of the valley heart. Today a small Indian group is permanently established in Indian Village on the edge of Furnace Creek Ranch. They live by basket weaving, road and construction work for the Park Service, and as ranch hands for the nearby oasis. Their impermanent brush huts have been supplanted by thick adobe dwellings.

The first whites actually to enter Death Valley evidently possessed none of the Indians' knowledge and experience. These emigrant groups, having left the Old Spanish trail to seek a shorter way to the California gold fields, descended Furnace Creek Wash on Christmas Day, 1849. Their Christmas present was the heartbreaking sight of shimmering salt flats backed by the precipitous barrier of the Panamint Mountains. The story of what happened later is not completely clear. The groups split as fear and hunger overcame reason and the inevitable loss of personnel, animals, and equipment followed. One group (Jayhawker Party) worked north, then crossed the Panamints into Panamint Valley and then pushed southward into the Mohave Desert. Another group (Bennett-Arcane-Wade party) crossed the salt flats and travelled south to camp at, or near, the site of Bennett's Well. Part of this group (Wade party) fearful of the consequences of waiting for the group's scouts to find a way over the towering Panamints, went south with their wagons out of the relatively open end of the valley and again reached the comparative safety of the Spanish Trail. The remainder (Bennett-Arcane party), abandoning wagons and much equipment were finally led by their returning

scouts over the Panamints, across the Mohave, and to the Los Angeles area. Thus, even in the cooler season, the first white visitors found the graben floor a place of disaster and death, a and of no conceivable utility.

It would not be true to say that these transients have left no imprint on Death Valley. Truly they established no settlements, opened no mines, built no roads, yet they have left names and legends that have become as much

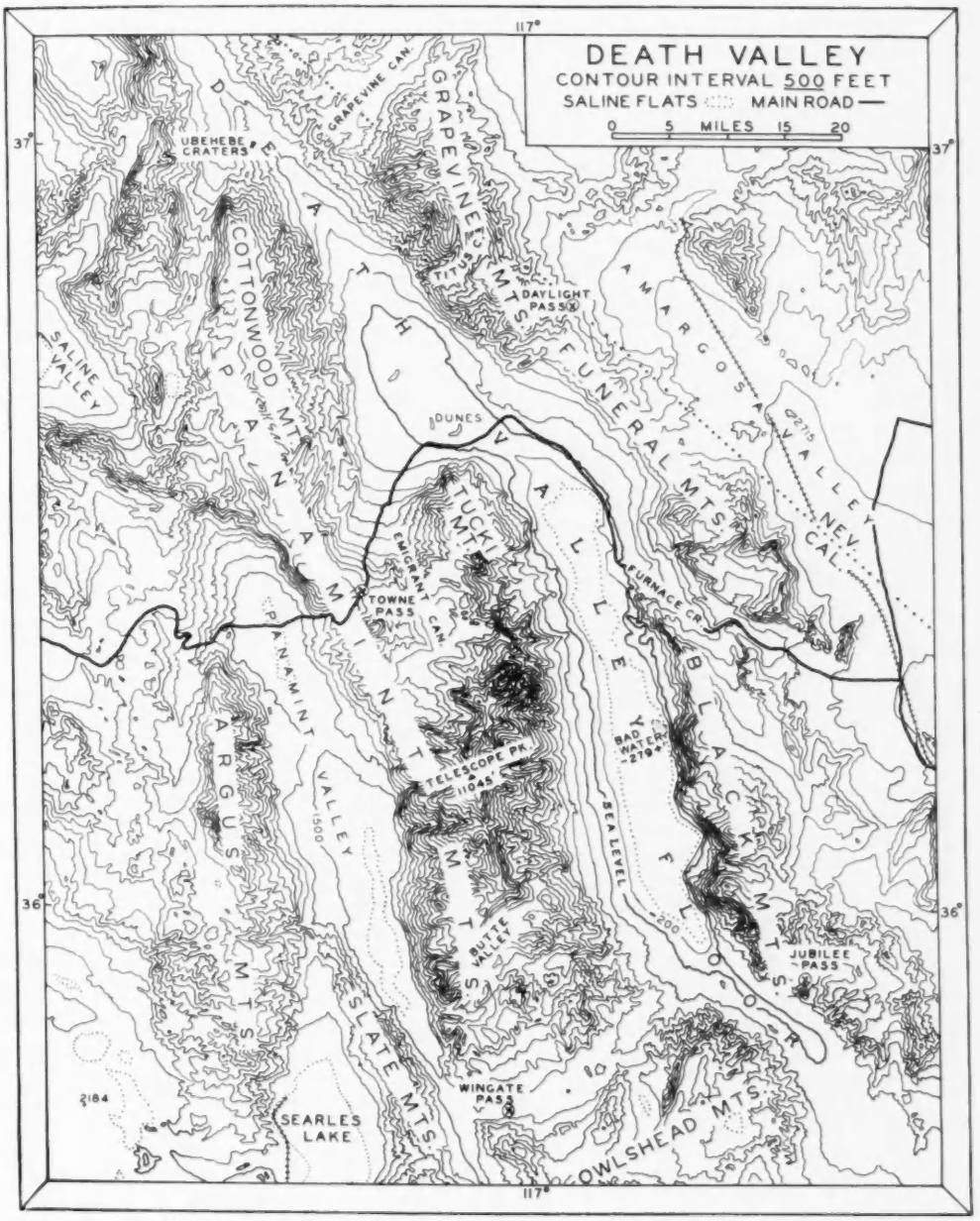

FIGURE 3.—Part of a mountain and bolson area, the Death Valley trench has its floor well below sea-level and its rugged rim thousands of feet above. (Contrast the altitude of Bad Water with that of near-by Telescope Peak.)

a part of the valley as the physical features. Unfortunately, their name for the great trench ("Valley of Death"), coupled with the magnification given their tales by time, has given the valley a character which sets it out unnaturally from many other essentially similar portions of the Great Southwestern Desert. Actually there are many "Death Valleys," valleys which differ only in degree and not in kind (Amargosa Valley, Panamint Valley, Saline Valley; one might list scores in both near and far-flung sections of this tremendous dry country).

The inauspicious introduction of the valley to the world, by the Forty-Niners, was followed in the "Sixties" by prospecting parties, miners, and a boundary commission. These groups and individuals worked in and out of the valley and along its high, rugged borders, as well as in adjacent areas. Again, no permanent attachments were made although territory was explored, routes discovered, or rediscovered, and described, and new place names appeared.

In 1870, Bellerin Tex Bennett established what is now called Furnace Creek Ranch (formerly Greenland Ranch) (Figure 6). Placed on the northern edge of the alluvial fan of Furnace Creek the ranch looks down the fan-slope to the mirages of the near-by salt flats and up-slope to a jumble of low hills and deep canyons which are in turn backed by the high reaches of the eastern mountains. Springs and "seeps" near the mouth of Furnace Creek Canyon made possible the establishment of this oasis which is now nearly seventy years of age. Ten years later the Harmony Borax Works acquired the ranch and produced alfalfa for the mules which for a few years hauled borax out of the valley. Today the ranch stands out sharply in the valley scene as a green rectangle surrounded by the grays and whites of the desert

FIGURE 4.—The upper portion of the gigantic Hanaupah alluvial fan, with Hanaupah Canyon and the Panamint Mountains in the background. The prominent snow covered peak is Telescope Peak. The white thread ascending the middle portion of the fan is a road. (See Figure 5 for location.)

sweep. Hardy imported tamarisks form a stockade against the often violent winds of the valley floor. Within the rectangle are alfalfa fields, a grove of producing date palms, a golf course, a small commercial center comprised of

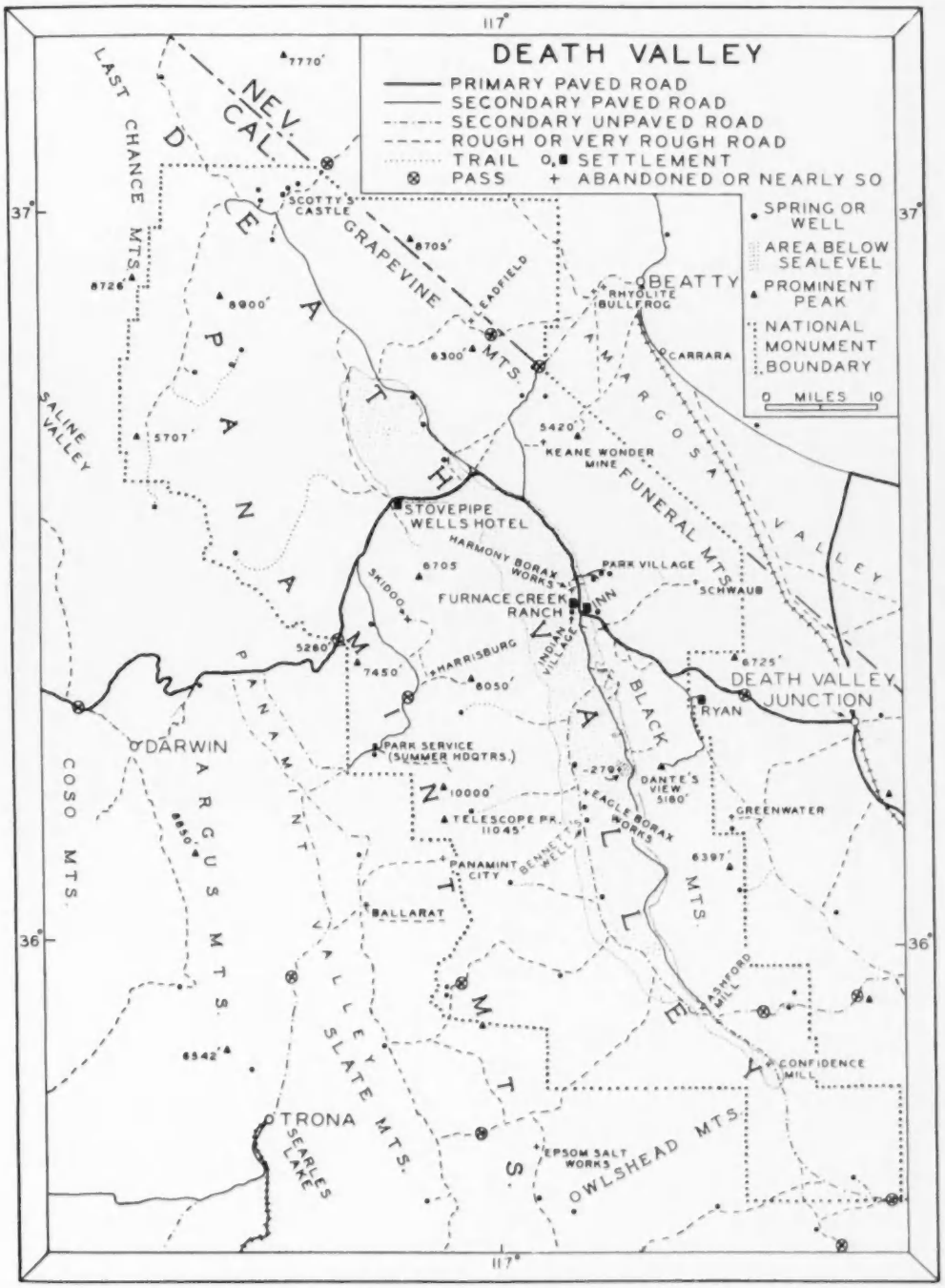

FIGURE 5.—The present Death Valley road system has evolved chiefly since 1926. The system reflects a north-south traffic flow in the valley floor and an east-west flow across rugged borderlands. (Compare Figures 3 and 5.)

post office, store, restaurant, oil and gasoline station, and some 150 cabins and cottages for visitors. For many years under the control of the Pacific Coast Borax Company "the ranch" is now one of the important tourist and recreation centers of the Southwest.

In 1871, government exploring parties worked in and near Death Valley (Wheeler and Lyle). Generalized maps were constructed, and the next year the Panamint mines opened to presage the Panamint Boom of 1874. The year 1873 marks the discovery of "cotton ball" borax in the highly saline debris of the valley floor. This resulted seven years later in the important, but impermanent (1880–1887), production of borax in the heart of the valley and gave rise to the world-famous twenty-mule-team wagons which traveled a hot, dry tortuous route out of the valley via Wingate Pass (Windy Gap) and on to the town of Mohave. Death Valley became of commercial significance and borax became synonymous with Death Valley; so much so that even today the general public believes that much of the United States borax supply is still grubbed from the salars of the valley bed. Other important items of this period were explorations by Lieutenant Rogers Birnie (1875), and the work of the Coville-Merriam scientific party (1891), the latter working especially along botanical, zoölogical, and ethnographical lines.

By the turn of the century many individuals and parties were prospecting around and in the Death Valley trough. These dangerous and often disastrous explorations led to the boom growth of gold and silver mining camps northeast of the valley, as at Rhyolite (1906) and Bull Frog (1904), and on the west, in the high Panamints, to such famous mining camps as Skidoo (1905). Today Death Valley is fringed by the remnants of many such settlements, now definitely ghost towns, some completely abandoned, some still supporting two or three families (Figure 5). Excepting the short-lived borax works and the Keane Wonder Mine (1903), no such settlements were established in Death Valley proper and, thus, some thirty-five years subsequent to the beginnings at Furnace Creek ranch there still were no additional permanent attachments to the valley floor.

In 1905, the United States Geological Survey constructed the first adequate map of Death Valley and many factors of location, distance, etc., were at last made clear. Very slowly then, over the half-century following the disastrous trek of the Forty-Niners, the true expression of the valley and its environs became at least moderately well known and understood. During that period the tales concerning the valley attracted some and repelled others. New routes were found or old ones (as Indian trails) re-established. These routes were slowly tied-in, over many miles of desert flat and mountain canyon, with the sketchy but growing transportation network of the desert country. Water holes acted as control points in the evolving pattern and the slowly moving freight wagons, carrying precious water in barrels and tanks, pushed as fast as possible to the next water supply. Miscalculation or unforeseen difficulties often meant a destination never attained.

From about 1905 to 1926 there were but few changes in the picture. Prospectors, "boom" camps, freight roads, etc., continued to play their parts. The valley itself was crossed and recrossed, but it still repelled more than it attracted. "Death Valley Scotty" became famous and many persons made fruitless search in and out of the valley for the mineral veins reputed to be the source of his evidently large income.

Railroads appeared on the scene but, like so many other elements in the course of settlement of the area, they did not penetrate the heart of the valley (Figure 5). With the mining area around Beatty, Nevada, as a node, three rail lines were constructed and put in operation between 1905 and 1907. The Las Vegas and Tonopah connected Las Vegas and the Beatty area via Indian Springs and Amargosa and sent a spur on north to the Goldfield-Tonopah area. The Bullfrog and Goldfield Railroad served Beatty and the section to the north. The third line, the longer lived and the more famous, the Tonopah and Tidewater Railroad, pushed north from the main trunk of the Santa Fe at Ludlow via Baker, Shoshone, Death Valley Junction to Beatty (Figure 2). Near-by Rhyolite was served by railroad and its citizens constructed an elaborate railway station to serve the peak population of some 12,000 persons. The year 1907 began the general collapse and today Rhyolite with a population of three persons has its now rail-less station as a monument to man's inability to see into the future. At present the Tonopah and Tidewater, the sole survivors of the rail lines, with its usefulness largely curtailed by the collapse of the "boom" towns and by the coming of trucks, busses, and family automobiles has Death Valley Junction as the most important settlement along its right of way. A narrow-gauge spur formerly reached from the Junction into the borax mines of the hills around Ryan, but with the shift of borax production to the Kramer area in the Mohave (Figure 2) in 1927 the spur was abandoned and the traffic of the main line suffered another drastic reduc-

FIGURE 6.—The junction of Furnace Creek, Washington, with Death Valley proper. Furnace Creek Ranch appears in the right foreground and the Inn at the apex of the alluvial fan. The main road from Death Valley Junction shows clearly on the slope of the alluvial fan of Furnace Creek. The mountains are the Black Mountains. (See Figures 3 and 5 for location.)

tion. A plant at the Junction still ships clays used for filtering purposes. However, the presence and modern utilization of Death Valley has helped to keep the railroad and the town in existence. As a rail head for the valley the town handles passengers and supplies and as a desert hotel and supply center it serves the needs of thousands of automobile travelers each year, chiefly travelers on their way to or from Death Valley.

Death Valley attracted the first automobile party in 1906, but it was not until the end of the World War period that automobiles began to push into the valley in any appreciable numbers. As in the case of many desert areas widely scattered over the earth it is the automobile that has allowed the real penetration and understanding of Death Valley. Cheap, fast transportation has not eradicated but it has largely shackled the repellent factors which in the past and under other conditions overshadowed the forces of attraction; in doing so it has allowed Death Valley to appear in its modern rôle.

In a strict sense, the modern period in the utilization and settlement of Death Valley begins with the year 1926–27. By that time automobile travel was demanding and obtaining improvement and relocation of roads. New highway connections with main trunk lines were being established, supplies and living accommodations were needed, not only in the large contiguous area but in the valley proper. The furnace-like heat of the May to October period still largely discouraged summer visitors but the cooler period saw them coming, first by the score, then by hundreds, and then, today, by the thousands.

Stovepipe Wells Hotel was established in 1926. Commanding a strategic point near the narrowing of the valley floor this resort and supply depot overlooks the Death Valley dunes (Figure 7) and on to the easterly wall of the Grapevines and the Funerals in one direction, and up the long slope of the Emigrant Wash fan to the Towne's Pass saddle of the Panamints in the opposite direction (Figure 5). The opening of the Eichbaum toll road from Darwin, in the same year, led travelers directly to Stovepipe Wells Hotel and furnished another modern link in the road net of the area.

Furnace Creek Inn, with already established modern road connections via Furnace Creek Wash to Death Valley Junction, was built, likewise in 1926, to supply a pretentious and luxurious counterpart for the near-by Furnace Creek Ranch (Figure 6). Located on the vari-colored hill slopes near the mouth of Furnace Creek Canyon, the inn faces down-slope to the ranch oasis and to the salt flats with their bleak backdrop of the central Panamint heights. It is literally on the major east-west route of the valley crossing, thus having through-road connections with Owens Valley and the Sierra Nevada country to the west and with the Las Vegas and Boulder Dam area to the east (Figure 2). In addition, there are north-south links which, joining with the east-west route, give access via main highways to such areas and points as the Mohave, Los Angeles, and Salt Lake City.

Death Valley View Hotel at the now inoperative borax mining settlement of Ryan (Figure 5) came into the picture in 1928. Located on the eastern slopes of the hills which overlook the Greenwater Valley offshoot of Furnace Creek Wash this establishment helps to accommodate the overflow from the oasis centers in the valley proper.

In 1933 the area became officially the Death Valley National Monument,

FIGURE 7.—The Death Valley dunes near Stovepipe Wells hotel, with the Panamint Mountains in the left background. (See Figures 3 and 5 for location.)

under the management of the National Park Service. Park Service personnel, using Civilian Conservation Corps labor, have established public camping sites and have played a large part in improving and constructing roads in the valley floor and into the gigantic canyons which debouch at the apices of the alluvial fans. In addition the Park Service provides lecturers, guides, emergency aid, etc. The coming of the Park Service has added another permanent oasis settlement, namely Park Village (Figure 5), which is located in the small canyon of Cow Creek some three miles north of Furnace Creek Ranch. Near by is the barracks village of the Civilian Conservation Corps.

That the present day attractive force of Death Valley is neither weak nor local, is indicated by the following statistics. In 1937, the valley was visited by 58,320 persons, an increase of some 19 per cent over the preceding year and an increase of more than 500 per cent during the five years preceding 1937. Of these, southern California, chiefly the Los Angeles area, supplied more than 34,000. The remainder came chiefly from other states and some from foreign countries. The great majority came in private automobiles and in busses. Some came by rail to Death Valley Junction and more than 200 arrived by airplane at the Furnace Creek landing field (Figure 6). Although official figures cannot be obtained it is estimated that visitors spent more than a third of a million dollars in the valley during the season of October 1938 to May 1939. This is the estimate of a business man familiar with the development of the valley during the last thirty years.

It is this ebb and flow of thousands of persons to the valley that accounts for the present degree of elaboration of the highways and services of a large section of the desert country (Figure 2). Many persons use the newly hard-surfaced road from Death Valley to Las Vegas to enable them to visit both the valley and the Las Vegas-Boulder Dam area on the same trip. Likewise they use the recently improved hard-surfaced road from Death Valley to the

Mt. Whitney area to visit the valley and the Owens Valley-Sierra Nevada country. It seems certain that neither of the above mentioned modern highways would be in existence were it not for the presence and nature of Death Valley. Money is spent not only in Death Valley but at many small and large oases along the way (Figure 2). Thus not only is transient population increasing but also stationary population nuclei which are supported in whole or in part by the desert travelers. As is often the case in none too favorable habitats, even a small cash income from outside sources may represent the difference between temporary and permanent attachment. In other instances, where settlements and connections are economically established in their own right there is, nevertheless, a welcome addition to local income. To arbitrarily take but one example, namely the railroad and highway junction town of Barstow, California (Figure 2): this desert center is about 180 miles by road from Death Valley, yet from late October to early May some 30,000 persons chiefly from the Los Angeles area stop on their way to or from Death Valley to purchase gasoline, oil, food, apparel, etc. Many remain overnight. No statistics are available yet it is apparent that from this single source many thousands of dollars are added to Barstow's annual income.

In summarizing the rôle of Death Valley certain facts and correlations stand out sharply. At first, a "Valley of Death" to the Forty-Niners; an isolated area little known and greatly feared. A little later, a region of scientific interest, a sort of natural, but repulsive, curiosity tucked into the great arid sweep of the southwestern interior, and, at the same time, an area of reputedly rich mineral veins which attracted those willing to gamble life against the opportunity for riches. The discovery and exploitation of borax, first in the valley proper and later on its southeastern flank, coupled with the "boom" silver and gold mining camps of the early 1900's which sprang up near by, brought freight roads and railroads, either into the valley or along its margin. These vital life lines began to show as threads attached to the ropes of the general transportation net of southern and east-central California and southern Nevada. Still later, the coming of the automobile brought a major transformation. The valley became fairly well known and this knowledge widely bringing to light as it did the magnificent physical set-up and the favorable climatic aspect of the cooler season resulted in an ever-growing elaboration of highways and services, both in and around the valley. Freed of the earlier stigma and of the very real danger consequent to slow travel in sparsely settled desert lands the valley has now achieved one type of use value. As a result there are highways and settlements where none might "normally" be expected. The sterile extent of the valley, disappointing though it has been from a mineral standpoint, has assumed an important rôle in the settlement pattern of the Southwest—its basic geographical expression has proved a resource more valuable and indestructible than that of minerals.

Death Valley does not stand as the sole utilization area of its own or similar kind in the southwestern arid country. Certain other spots and areas of similar function are entering, or have entered, the picture and these likewise are affecting the settlement pattern, especially by adding to the highway system and to the associated services and population nodes of either large or small sections. This is not the place for an

exhaustive listing but a few examples may nevertheless be taken. The growing attractive force of desert-fringed Lake Mead is strongly affecting the entire Boulder Dam area from Las Vegas, Nevada, to Kingman, Arizona. Far away, in the Coachella Valley at the northern foot of the San Jacinto Mountains the famous resort oasis of Palm Springs is another case in point (Figure 2). Still another is the resort oasis of Twentynine Palms located in the southern Mohave on the northern edge of the Joshua Tree National Forest.

Not only in the Death Valley area but also, then, in other districts of the Southwest the existence of certain physical set-ups abetted by present-day demands and modern methods of transportation is creating a new type of desert land use. This newer utilization is slowly overcoming the elements of isolation and aridity and in so doing is filling some of the gaps in the pattern of settlement.

RAILWAY ENTRANCES AND EXITS TO LOS ANGELES

John H. Kemler

AT Los Angeles can be seen a striking example of coincidence between the railroad pattern and the pattern of topographic features, such as lowlands and passes through mountain ranges. This coincidence, in turn, helps in an understanding of Los Angeles as a trade center and its place in the railway pattern of the Southwest.

The largest coastal lowland in California fronts on the Pacific Ocean between Santa Monica and Balboa in Southern California. From this flattish area, roughly trapezoidal in shape, extend two elongated valleys. The larger lowland, or "The Valley" as it is locally called, lies to the east between the Sierra Madre and San Bernardino Mountains on the north, the San Jacinto Mountains on the east, and the Santa Ana Mountains of the Coast Range on the south. The smaller one, or San Fernando Valley, lies to the northwest of the coastal lowland between the Santa Monica and Sierra Madre Mountains.

For the purposes of this discussion, these three connected parts, the coastal lowlands, "The Valley," and the San Fernando Valley, make up the area I choose to call Los Angeles. The area roughly coincides with the Local Plain District of the Trade Region of the Port of Los Angeles as it was described and defined by Willis Miller in his study on the Port of Los Angeles. The *city* of Los Angeles itself covers a significant portion of the area and dominates the life within the whole district. It is the transportation hub of the entire southern part of the state.

Seven railway entrances and exits are scattered around Los Angeles. Beginning with the northeasternmost and proceeding in a clockwise fashion, they are the Cajon Pass, the Gorgonio Pass, the Box Springs Grade, the San Juan Capistrano Pass, the Harbor, the Santa Susana Pass, and the Santa Clara Pass. On the map the entrances and exits have been highlighted by placing over them a dotted strip roughly five miles in width.

The main line of the Union Pacific Railroad from Salt Lake City and the main line of the Santa Fe Railway from Needles and eastern points cross the Mojave Desert and meet before entering the deep notch in the Sierra Madre–San Bernardino mountain wall known as the Cajon Pass. On tracks owned by the Sante Fe (except for a few miles on the south side of the summit) trains rapidly climb from the high surface of the desert to a summit of about 3,800 feet and then wind down to about 1,000 feet at San Bernardino at the southern end of the Pass. A little beyond San Bernardino, Union Pacific trains return to their own right of way.

The Golden State and Sunset Routes of the Southern Pacific Railway from Chicago and New Orleans cross the Colorado River at Yuma, Arizona, traverse the low, flattish Imperial Valley, and enter Los Angeles from the east through the Gorgonio Pass, climbing from near sea-level to an elevation of about 2,600 feet and descending to Colton at 978 feet.

A branch line of the Sante Fe from the Hemet Valley enters over the Box Springs Grade. The summit is reached at about 1,500 feet and the route descends to about 900 feet above sea-level at Riverside.

After leaving a route close to the shore at San Juan Capistrano, the Sante Fe line between San Diego and Los Angeles cuts inland through a low entrance between the Santa Ana Mountains and the San Juan Capistrano Hills.

Since 1929, the Harbor Belt Line Railway has been operating in the Port District and has managed the railway properties and 128 miles of railway tracks owned by the City of Los Angeles, the Southern Pacific, the Sante Fe and the Union Pacific. The harbor entrance involves no problems of grade. Throughout, it is only a few feet above sea-level.

From the northwest, the Southern Pacific Coast Line from San Francisco, via Santa Barbara and Ventura, enters from the lower reaches of the Santa Clara Valley through the Santa Susana Pass. A tunnel near the summit is about 1,100 feet above sea-level and leads the route to Chatsworth at a 950 foot elevation.

The San Joaquin Line of the Southern Pacific Railway traverses the Mojave Desert and enters the Santa Clara Pass near Palmdale at about 2,650 feet above sea-level. The route follows the valley of the Santa Clara River to a point near Saugus and there it turns sharply to the southeast, tunnels through a mountain, and descends to San Fernando at an elevation of about 1,000 feet.

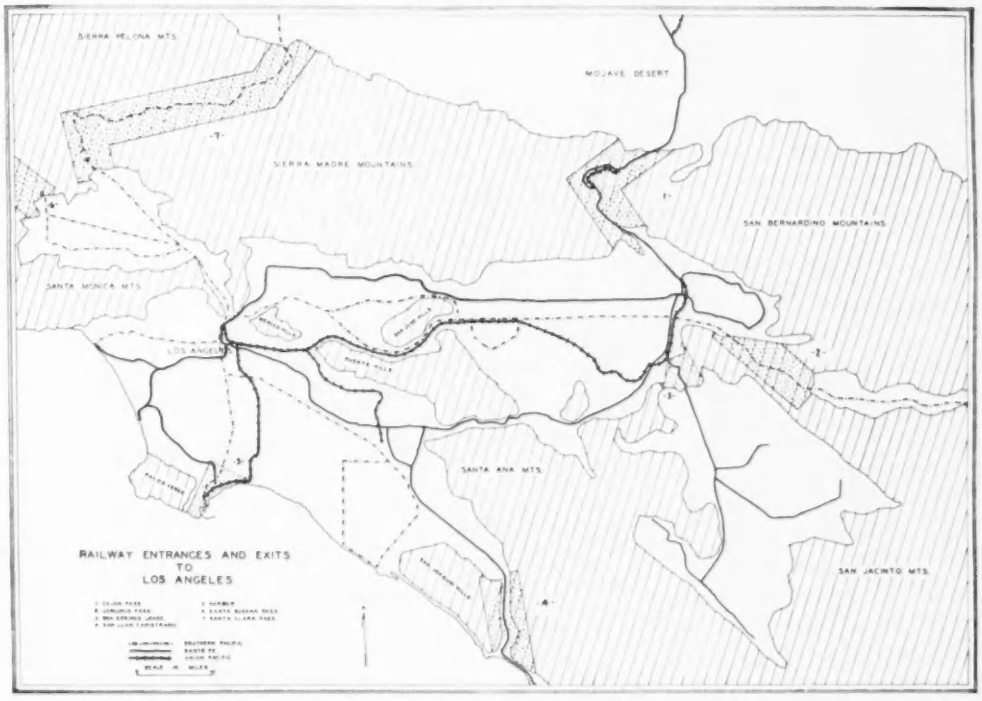

FIGURE 1.—The six railway entrances and exits to Los Angeles are indicated by the dotted strips approximately five miles in width. They help to emphasize the position of Los Angeles in the rail transportation system of Southern California.

The entrances and exits may be divided into two groups. Those of one group are the entrances and exits through the Santa Monica-Santa Pelona, Sierra Madre-San Bernardino-San Jacinto mountain wall. They are high, often narrow and winding, and usually require elaborately constructed aids to allow the trains to maneuver the high summits

and relatively steep grades. This group includes the Santa Susana, Santa Clara, Cajon, and Gorgonio Passes. The other group is made up of the lower entrances and exits with less steep grades and include much less elaborate construction incident to the building of the railroad right of way. In this group are the Box Springs Grade, San Juan Capistrano, and Harbor entrances and exits.

The entrances and exits on the northwest, north, and east are the only gaps which could be used by railroads from those directions with any justifiable expenditure for construction and maintenance to provide grades which are low enough to result in reasonable operating conditions. Accordingly, when the railroads first came to Los Angeles, it was a matter of "first come-first served" in controlling a right of way through the available passes. By the time the Los Angeles and Salt Lake Railway Company, a subsidiary of the Union Pacific, was ready to construct its line, it had to make arrangements with the Sante Fe for rights over the Sante Fe tracks through the Cajon Pass.

The general pattern of lowland, mountain and sea barriers, and passes suitable for railway use between the lowlands and the surrounding land and sea areas emphasizes the strategic position of Los Angeles with reference to the distribution and character of the railway entrances and exits and traffic flow. The principal land traffic movements are east-west from the coast to inland points and northwest-southeast along the coast. These routes of flow intersect at Los Angeles. Once the development under the aegis of Spanish religious and secular institutions had begun, and the routes of travel and trade were being formed, the lowland began to function in its modern capacity as an intersection point. Man sought out the only routes into this area which were practicable in view of the particular arrangement there of lowlands, mountains, sea, and passes. Later, railway companies found these established routes most satisfactory for their own use and promptly adopted them.

The passes through the mountain barriers and the lowlands connected by them were vital features in the natural pattern which made it possible for man thus to link Los Angeles into the railroad net of the country. Man could not have developed Los Angeles as he has if there had been barriers and lowlands without passes. The presence of the entrances and exits, their number, distribution, and the direction of their axes with reference to Los Angeles has had a tremendous and forceful influence on human development of the lowland area.

LAND USE IN THE BLUEGRASS BASINS

R. W. Johnson

PERHAPS there are no two farming areas in the United States which have greater agricultural significance per square mile of area, which are better marked on a physiographic map, and which are more frequently referred to in the geographic literature of our country than the bluegrass basins of Tennessee and Kentucky. It is the outstanding agricultural importance and the striking similarity in the general appearance of these two noncontiguous areas which have created sufficient interest on the part of the writer to make this study of their land utilization.

Similar Phases

These basins are strikingly similar in many ways. Both appear as bowl-shaped depressions with their floors standing from 300 to 500 feet below the uplands which surround them, both have developed by the erosion of a structural dome, both are underlain with non-resistant rock which belongs to the Ordovician age, both are surrounded by escarpments whose younger rock belongs to the Silurian and later ages, and both have weathered into soils of high productivity particularly suited for the growing of bluegrass. Furthermore, man has developed a commercial livestock and crop farming system of agriculture on each. Finally, the first settlers who came into the two basins were of common ancestry, for both groups came by way of the Great Appalachian Valley to the point where one group moved over the Wilderness Road to the Kentucky Basin, and the other group followed an overland trail to the Tennessee Basin.

Dissimilar Phases

First, the population patterns in their various ramifications show marked differences in the two basins (Figures 1 and 2); for the number of people per square mile is 104 in the Kentucky Basin and only 74 in the Tennessee Basin, the percentage of rural population is 45 in the former as compared to 62 in the latter, the ratio of the total population negro is 12 per cent in the former but increases to 20 per cent in the latter, the ratio of rural people who are farmers is 63 per cent in the former and 69 per cent in the latter, and the percentage of all gainful workers who are engaged in agricultural work is only 25 in the former basin as compared to 35 in the latter basin. Second, the land-use patterns show equally as great a margin of variation, for even though each basin has 90 per cent of its total land area in farm land, the allocation of farm land is decidedly dissimilar (Figure 3). Of the total farm land in the Kentucky Basin 28 per cent is in crops, 62 per cent is in pasture, 5 per cent is in forests, and 5 per cent is used for other purposes. In the Tennessee Basin, 40 per cent is in crops, 45 per cent is in pasture, 11 per cent is in forests, and 4 per cent is used for other purposes (Figure 4). Furthermore, the crop combination and the livestock association vary widely in the two basins as will be shown in detail later in this study (Figures 5 and 6). Accordingly, the next procedure is to define the limits of the areas under discussion and then investigate those phenomena of the natural and cultural heritage which throw most light on man's occupance and use of the land.

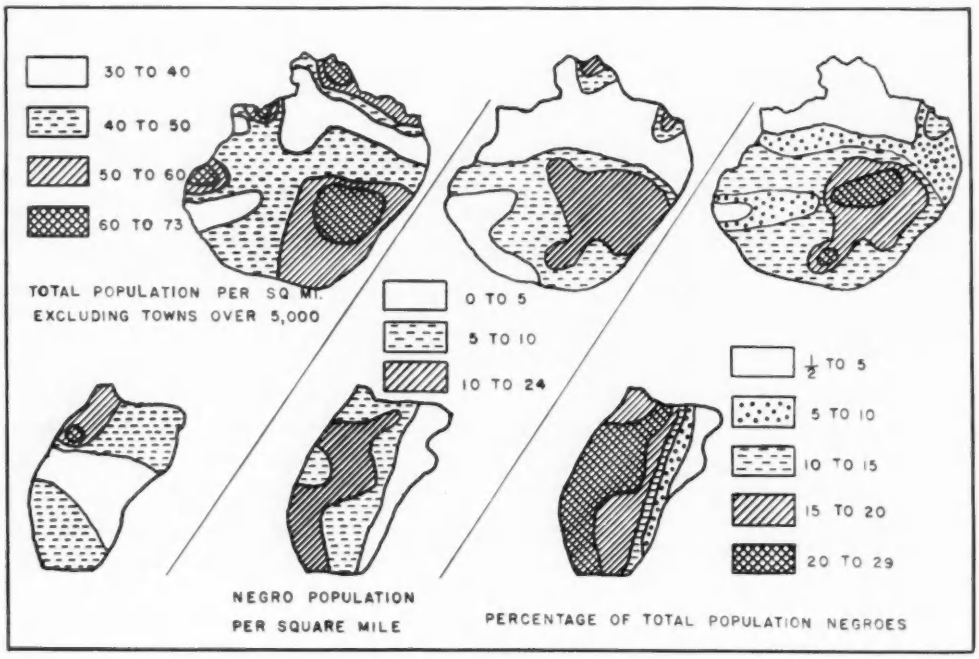

FIGURE 1.—Density of population per square mile excluding towns over 5,000, negro population per square mile, and percentage of total population negroes.

EXTENT UNDER INVESTIGATION

Owing to the fact that this paper is built on a statistical base, the entire part of all counties which lie wholly or largely in the basins as shown in Figure 7 are included in it. The area of the Kentucky Basin as shown in Figure 8 is slightly larger than that shown in Figure 7, for it contains a narrow crescent strip on the west and south where the surface and structure vary slightly from the other part. The boundary of the Tennessee Basin as shown in Figure 8 is also slightly different from the one shown in Figure 7 because the political and physical boundaries do not exactly coincide. As used in this study, the Bluegrass Basin of Kentucky embraces 39 counties with an area of 9,916 square miles, and the corresponding area in Tennessee embraces 16 counties with an area of 6,986 square miles, or 70 per cent that in Kentucky.

CLIMATIC, EDAPHIC, AND TOPOGRAPHIC CONDITIONS

Wherever land is used primarily for agricultural purposes, man's chief adjustments to elements of the natural milieu are to climatic, edaphic, and topographic conditions. Since, however, the mean annual precipitation of 48 to 50 inches in the Tennessee Basin exceeds that of the Kentucky Basin by only four or five inches, since the maximum and minimum temperatures are only five or six degrees higher in the former than in the latter, and since the growing season of about 200 days in the Tennessee Basin is only about 20 more than that in the Kentucky Basin, climatic differences fail to give a rational explanation of all of the minute differences in land utilization in the two basins.

With the climatic element eliminated by its striking similarity in both basins, the next step is to examine the adjust-

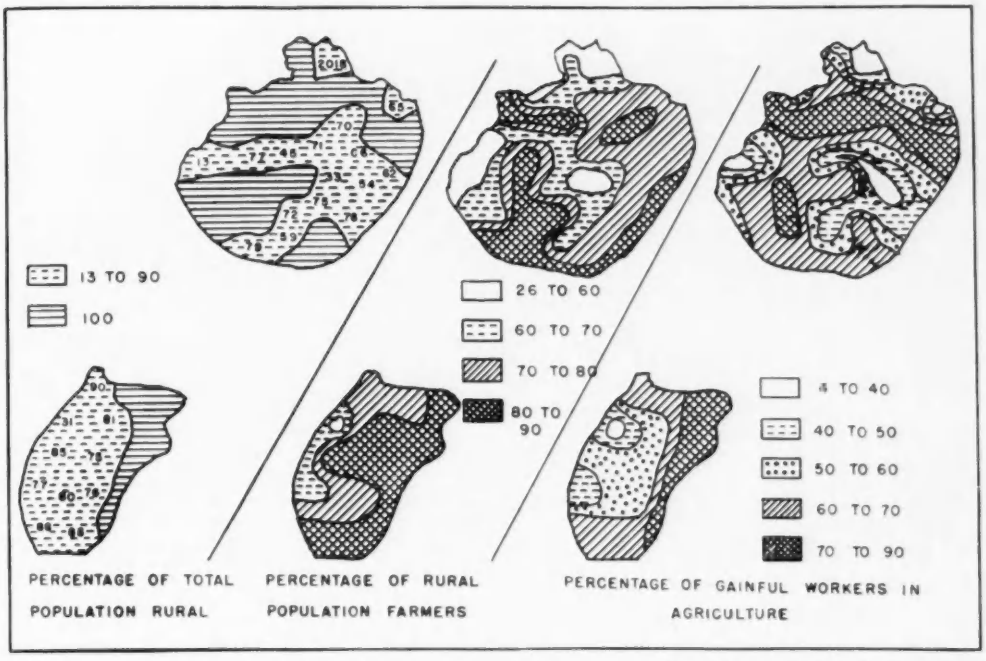

FIGURE 2.—Percentage of total population rural, percentage of rural population farmers, and percentage of gainful workers in agriculture.

ments of the occupants to topography and soil. Both of these phenomena are closely related to the underlying rock from which the basins were formed. In both basins the underlying rock is basically limestone, but the physical composition of the rock varies widely from place to place. Where the underlying strata are high in phosphatic content and uniform in resistance, they break down into a deep soil, dark in color, very productive, forming a level to gently rolling surface; on the contrary, where the strata contain a high percentage of sandstone, chert, or shale and are of unequal resistance, they have broken down into a hill type of topography with soils shallow in depth, lighter in color, decidedly lower in plant food, and more conducive to erosion.

The Kentucky Basin.—The uniform rock strata in the Kentucky Basin form a far more regular pattern than the strata in the Tennessee Basin do. Consequently, the corresponding soil belts in the former basin form three distinct zones: an inner zone known as the Inner Bluegrass, a middle zone known as the Eden Shale Belt, and an outer zone known as the Outer Bluegrass (Figure 9). Land utilization in these three subareas varies widely in accordance with the marked variation in soil and topography.

The Inner Bluegrass subarea contains 2,400 square miles, is underlain by Lexington and Cynthiana limestone strata, and possesses a level to gently rolling topography, except along the flanks of the Kentucky and Dix rivers and their tributaries. The chocolate colored soils formed from the Lexington formation are more fertile than the reddish soils formed from the Cynthiana formation because they contain a higher phosphorus content. The soils of this subarea as a whole, however, are better than those in the Eden Shale Belt (Figure 10).

The Eden Shale Belt has been so

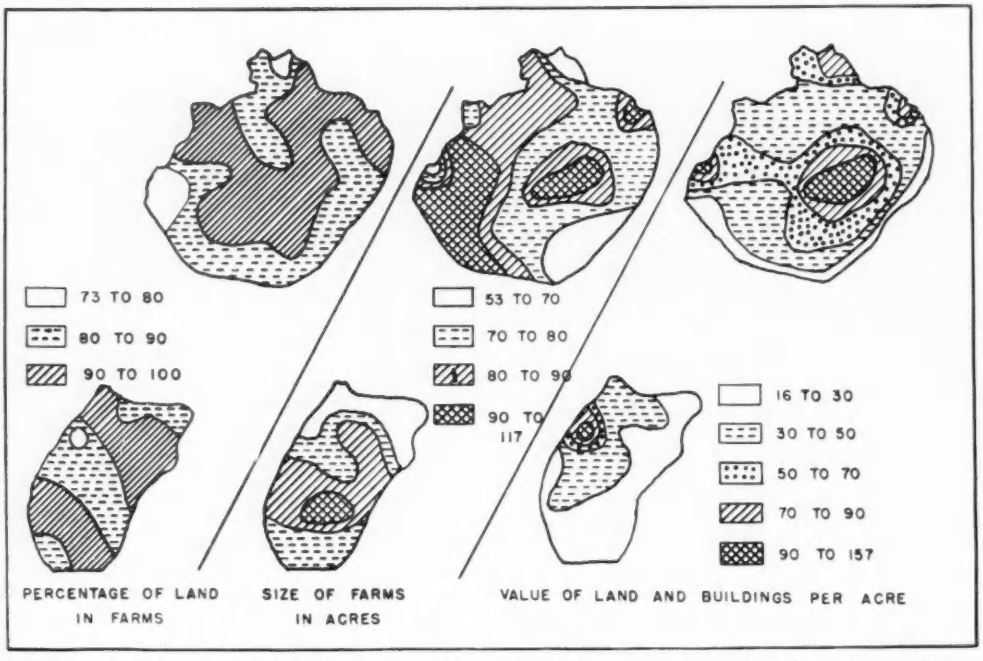

FIGURE 3.—Percentage of land in farms, size of farms in acres, and value of land and buildings per acre.

named because the underlying strata are predominantly shales with thinner alternating layers of limestone and sandstone. It contains about a hundred square miles more area than the Inner Bluegrass. The width of this belt varies from thirty miles on the north to less than one mile on the south (Figure 9). The topography of this maturely dissected subarea is that of a ridge and valley type, and erodes easily when planted in row crops (Figure 11). The soils are yellowish in color and are often thin and poor, particularly on the steep slopes. The amount of forest land and of waste land is considerably higher in this belt than in the Inner Bluegrass subarea. Accordingly, the land is much cheaper, farms are smaller, homes are decidedly poorer, roads are crooked and inferior, and the entire economic status of the belt is far below that of the Inner Bluegrass.

The Outer Bluegrass Belt surrounds the Eden Shale Belt, and contains approximately fifty per cent of the total area. It is underlain by alternating layers of limestone and shale but the limestone strata predominate, hence the surface is much more like the level to rolling land of the Inner Bluegrass than the dissected lands of the Eden Shale Belt. The underlying limestone strata are known as the Maysville and Richmond formations and have broken down into soils of a fair depth and of medium to high fertility, for they contain a rather high phosphorus content (Figure 12). Even though the land is about as level and the soil is almost as fertile as that in the Inner Bluegrass zone, the Outer Bluegrass zone is not so desirable because it is less compact. A narrow strip lying along the west and south margins of this subarea has less fertile soil because of a low lime and phosphorus content, and the surface is broken by more hills and knobs (Figure 9).

The Tennessee Basin.—The soils in

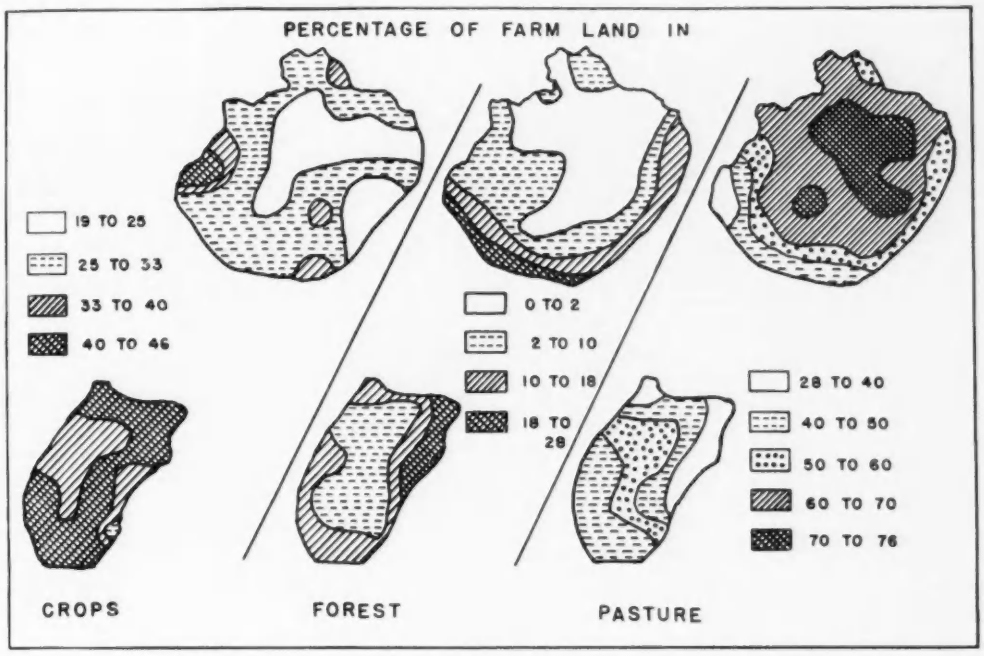

FIGURE 4.—Percentage of farm land in crops, forest, and pasture.

the Tennessee Basin are neither as deep nor as fertile on the whole as those in the Kentucky Basin, and the land surface contains a considerably higher percentage of glades, hills, and knobs (Figure 13). Furthermore, the Kentucky Basin has been subdivided into zones on the basis of topography and soil; whereas the areas of low productivity in the Tennessee Basin are not localized into zones but form a mosaic of striking irregularity. The numerous differences in the various phases of the population pattern, the marked contrast in the allocation of farm land, the lower land values, and the lesser desirability of this basin as compared with the Kentucky Basin are therefore closely related (1) to a greater percentage of glade, hill, knob, and ridge land, and (2) to the fact that these uplands are so universally scattered throughout the basin that sizable areas of level to gently rolling topography similar to those in the Inner and Outer Bluegrass subareas are very scarce or entirely lacking (Figures 10, 12, and 13).

The Kentucky Basin with its high percentage of arable land as a result of its more favorable topography supplies the needs of about 40 per cent more people per square mile than the Tennessee Basin does. The basin not only supports more people but it supports a type of people whose economic and social status is presumably higher, for only 12 per cent of its total population is negro as compared with 20 per cent in the Tennessee Basin. The higher productivity of the Kentucky land is further reflected through the urban population, for 55 per cent of all the people are urban as compared with 38 per cent in the Tennessee Basin.

THE HUMAN ELEMENT AS REFLECTED IN THE ALLOCATION OF FARM LAND

The human element cannot be overlooked in analyzing the occupance and use of any region. There is no doubt

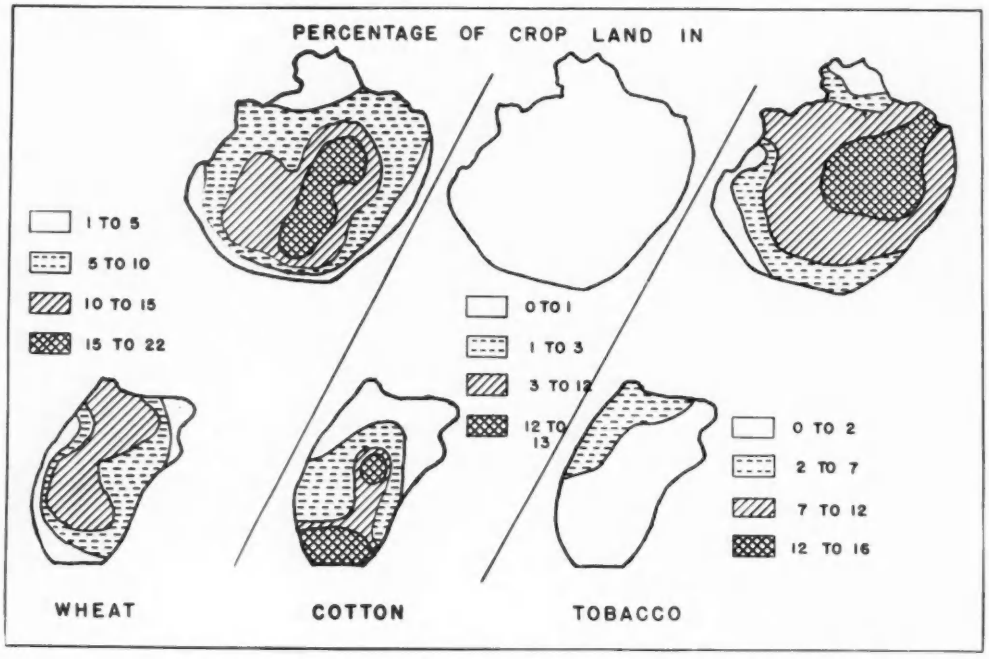

FIGURE 5.—Percentage of crop land in wheat, cotton, and tobacco.

that this element has played its part in the way the land is utilized in these basins. The people in the Kentucky Basin use less farm land for crops and keep considerably more of it in plowable pasture. Thus they have developed an extensive-intensive type of agriculture which has been handed down from one generation to another. Tobacco growing forms the intensive phase, and the livestock-feed-crops-pasture combination forms the extensive phase. Both phases are closely related to bluegrass. Bluegrass thrives on the limestone soil, furnishes excellent pasturage for the livestock, prevents soil erosion, and preserves soil fertility. Moreover, the longer the land remains in bluegrass pasture, the more suitable it becomes for tobacco, the intensive crop (Figure 14). That about 62 per cent of all farm land is allotted to pasture while only 28 per cent is allotted to crops in the Kentucky Basin is explained in part by the nature of tobacco as a crop. Tobacco is preferably planted on virgin soils or freshly broken bluegrass sod, and it is best not to grow two crops of tobacco on the same land in succession. The value of an acre of tobacco is relatively high, several times that of either corn or cotton; therefore, it is not necessary to utilize the same land for tobacco more than once every five to fifteen years. After adding to the acreage of land used for tobacco an amount sufficient to produce all the corn, hay, and other farm crops needed for local consumption, from one-half to three-fourths of the farm land is still left. Most of this land is utilized for bluegrass pasture.

Farming in the Tennessee Basin is more of the extensive type composed of a livestock-feed-crops-pasture combination very similar to that in the Kentucky Basin. Approximately 40 per cent of the farm land is in crops and 45 per cent is utilized for pasture. Considerably more of the pasture, however, is perma-

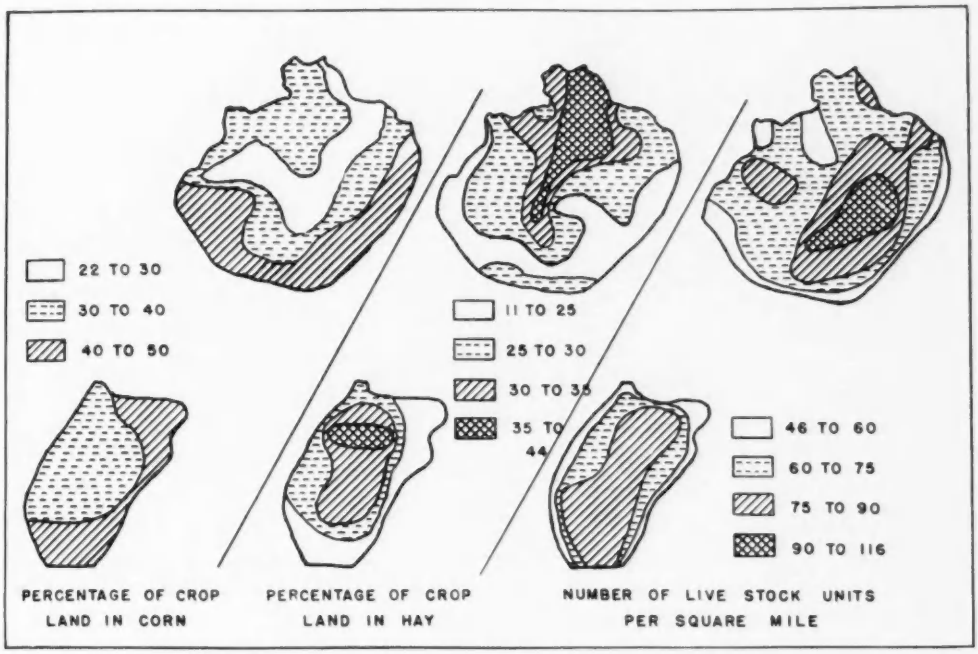

FIGURE 6.—Percentage of crop land in corn, hay, and number of livestock units per square mile.

nent pasture and is an adjustment of the people to the numerous hills, knobs, and ridges of the area, many of which have soil entirely too shallow to be plowed or to grow cultivated crops (Figure 15). The smaller ratio of plowable pasture land as compared with the Kentucky Basin is due not only to the topography of the land, but also to the lack of a major crop (tobacco) requiring a mature bluegrass sod. Unlike the people of the Kentucky Basin with two major sources of revenue, tobacco and livestock, the people of this basin depend largely on one, livestock. Consequently, a larger ratio of the farm land is necessary for growing such forage crops as corn and hay for feeding the livestock.

That 11 per cent of the farm land in the Kentucky Basin and only 5 per cent in the Tennessee Basin are in forests is in perfect harmony with the difference in topography in the two basins. Most of the forest land in the Kentucky Basin is on the dissected lands in the Eden Shale Belt. Similarly, most of the forest land in the Tennessee Basin is on the glades and the slopes of the knobs and ridges, but the location of these wooded uplands is different in that they are scattered throughout the entire basin.

THE CROP COMBINATION

Mention of certain crops has been made in the previous subdivision of this study, but only insofar as they related to the major uses of farm land. A detailed analysis of the crop combination has been reserved until now, the logical place, for its treatment. Six crops occupy 83 per cent of the total cultivated land in both areas, and while the ratios of the grain crops are fairly similar in both areas, those of tobacco and cotton are wholly dissimilar as shown in the table.

FIGURE 7.—Physiographic map of a section of United States showing the bluegrass basins of Tennessee and Kentucky. (From Lobeck's Physiographic Diagram of the United States.)

PERCENTAGE OF CULTIVATED LAND IN SIX LEADING CROPS

	Kentucky Basin	*Tennessee Basin*
Corn	35	39
Hay	28	28
Wheat	11	9
Tobacco	8	1
Cotton	0	4
Oats	1	2
	83	83

A large part of the farm land in both basins is in bluegrass, and a considerable part of the farm income in the Kentucky Basin is derived from the sale of bluegrass seed. Bluegrass seed mixed with clover or alfalfa seed is commonly sown with one of the small grains. After one or two years the bluegrass takes possession of the land for the remaining part of the crop cycle (five to ten years). A common rotation includes bluegrass for five to ten years, then tobacco on the most desirable parts of the freshly broken sod, followed by corn, then a small grain, and then the land is seeded in clover or alfalfa and bluegrass. Not all the land plowed any one year is needed for tobacco, so the part least desirable for tobacco is planted directly in corn (Figure 14).

Commercial crops.—Of the six leading farm crops in acreage tobacco, cotton, and wheat are grown primarily for commercial purposes; and corn, hay, and oats are, in the main, subsistence crops. Tobacco of the White Burley variety is the most important commercial crop in the Kentucky Basin, and a knowledge of the rôle it plays in the intensive-extensive type of farming offers an excellent insight into the crop combination. Only about 28 per cent of all farm land is in cultivation, and only 8 per cent of that is in tobacco. However, the high yield of 500 to 1,500 pounds per acre and the relatively high price of tobacco as compared with other farm products make it by far the most important source of revenue derived from farm crops (Figure 14). The area with the largest tobacco acreage (12 to 16 per cent) forms a pear-shaped pattern, and lies just across the Ohio River from Brown County, Ohio, the place where White Burley originated (Figure 5). Nearly four-fifths of the country's annual production of approximately 280,000,000 pounds of White Burley is grown in Kentucky and the principal Burley area coincides with the Bluegrass Basin. Only about one per cent of the cultivated land in the Tennessee Basin is utilized for tobacco, and most of this acreage lies in the margin of the dark tobacco belt of Kentucky and Tennessee which centers around Hopkinsville and Clarksville. That tobacco occupies 8 per cent of all crop land in the Kentucky Basin and only about one per cent in the Tennessee Basin is due far more to the origin and present location of America's Burley tobacco belt than to superior soil and topographic conditions in the former basin. Raymond E. Murphy, in his article "Land Values in the Blue Grass

and Nashville Basins," published in the April 1930 issue of *Economic Geography*, states that the difference is largely a matter of chance.

Cotton, a commercial crop in the Tennessee Basin, occupies about 4 per cent of the cultivated land, but in the southern end of the basin the ratio reaches as high as 12 or 13 per cent (Figure 5). The deflection of the boundary of the cotton region to the north at this place reflects the high productivity of the basin's limestone soil. As a commercial crop, cotton is a

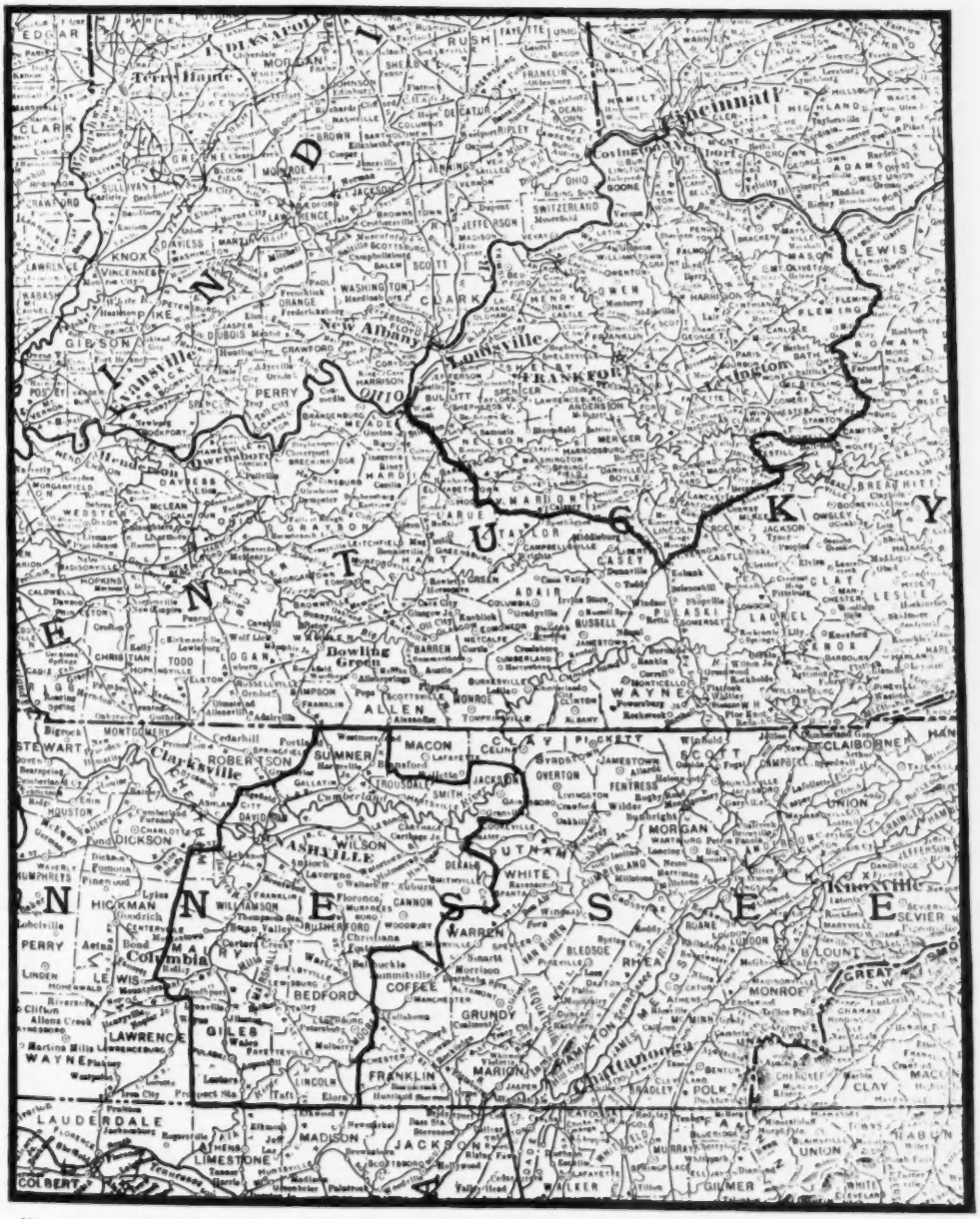

FIGURE 8.—Political map of the section of the United States containing the bluegrass basins of Tennessee and Kentucky. Towns, counties, railroads, and rivers are shown. (Photographed from a large wall map of the United States published by Rand McNally and Company.)

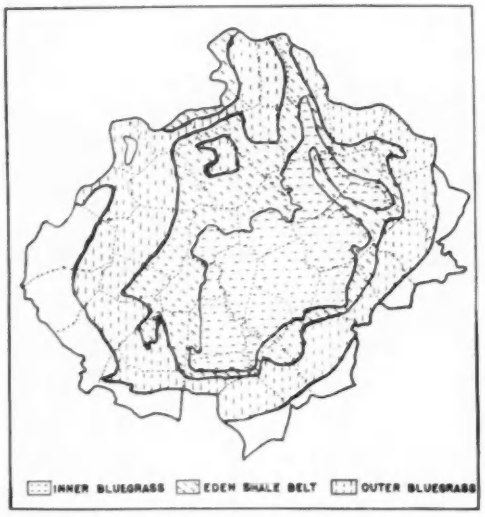

FIGURE 9.—Map showing subareas of Bluegrass Basin of Kentucky. The strip of land along the west, south, and east margins shown in white is formed from strata of a later geologic age than those in the major part of the basin. This belt contains a highly dissected topography and less fertile soil. The Inner and Outer Bluegrass and Eden Shale Belt are formed from Ordovician limestone. The Inner and Outer Bluegrass subareas are very fertile and have a level to rolling topography. The Eden Shale Belt is a ridge and valley type of land with a poorer soil as a result of a high percentage of sandstone, shale, and siliceous content in the underlying limestone. This belt has also suffered heavily from erosion.

poor second as compared with tobacco in the Kentucky Basin. The farmers in the Tennessee Basin must derive more cash from livestock, and this means that more of the land must be utilized for feed crops, particularly corn and hay.

Although the wheat acreage is not high for an extensive crop, it, nevertheless, serves three purposes: as a nurse crop, as a winter cover crop, and as a money crop. In addition to these, wheat fits well into the crop rotation and enables the farmer to distribute the farm work. The largest acreage of wheat lies in the central part of the basins where the soils are highly productive and where the level to rolling topography is suitable for the operation of large machinery (Figure 5).

Subsistence crops.—All three of the commercial crops utilize a relatively small proportion of the cultivated land as compared with corn and hay which use 67 per cent of the total crop land in the Tennessee Basin and 63 per cent in the Kentucky Basin (Figure 6). To understand the relative importance of these two crops, it may be stated at this juncture that a major source of revenue in both areas is livestock. That several times as much land is needed for livestock farming as for tobacco or cotton farming needs no explanation. Livestock must have an abundance of feed before they reach a finished state ready for the market. Corn and hay supply this need better than other crops, especially during the winter season. Therefore, corn and hay are grown almost exclusively for feed crops in both basins. The percentage in hay is 28 in both basins, and the percentage in corn in the Tennessee Basin is 39 against 35 in the Kentucky Basin. The lower acreage utilized for feed crops in the Kentucky Basin is, no doubt, due to the importance of tobacco. Some farmers prefer to leave more of their land in bluegrass for a longer period of time, even if they have to buy part of the corn needed for feeding the livestock. The largest corn acreage in both basins lies in a narrow zone stretching along the southern and eastern margin of the basins. Conversely, the largest hay acreage lies in the north and north-central parts of the basins where the urban population and dairy cattle are relatively high and where the commercial crops, cotton and tobacco, are of relatively low importance.

Oats utilize about one per cent of the cultivated land in the Kentucky Basin and double that amount in the Tennessee Basin. Although climatic conditions are not the best for oats in either basin, they fit well into the crop rotation, and

they make fine feed for livestock when fed either as grain or as hay.

The remaining 17 per cent of the cultivated land is utilized for a large number of crops, no one of which occupies more than two or three per cent of the total. An analysis of the land utilized for these miscellaneous crops is omitted from this study.

LIVESTOCK ASSOCIATION

Horses and mules.—Although the livestock phase of farming in both basins is of major importance, especially from a land-use point of view, it is somewhat different in character, particularly in the Kentucky Basin, than is popularly supposed. This misconception is due, in all probability, to the fact that race horses were brought to the Inner Bluegrass subarea soon after the close of the Civil War, and that the development of racing and the breeding of race horses have been enterprises on which huge sums of money have been spent, especially by the more wealthy and sport-loving class of people. In the vicinity of Lexington, the heart of the Inner Bluegrass subarea, there are many celebrated stock farms on which the Thoroughbred, Standard Bred, and the Saddle Horse are produced. The Thoroughbred horse produced here has gained both national and international fame. Among those of high rank and familiar to all are Gallant Fox, Twenty Grand, Omaha, War Admiral, Seabiscuit, and the most famous of all, Man o' War. On other farms of slightly less renown are produced pure-bred Hereford and Jersey cattle. These celebrated farms are called locally "show places" because of their level to gently rolling terrain, beautiful grove-like pastures, snowy white plank fences, unusually fine barns, and beautiful homes set in spacious well-shaded lawns (Figure 16).

FIGURE 10.—Fine herd of Hereford cattle grazing on an excellent bluegrass pasture in Scott County near the northern edge of the Inner Bluegrass subarea. Note the gentle slope of the land and the grove-like appearance of the pasture.

The localization of the breeding of fine race horses as it exists today in Fayette County is due in no small measure to geographic inertia. Murphy says that this enterprise started in the Kentucky Basin rather than in the Tennessee Basin largely as a matter of chance. Certainly there are counties in the Tennessee Basin whose physical conditions are well suited for the enterprise. In fact, there are 77 livestock units for every square mile in the Tennessee Basin as compared with 75 livestock units per square mile in the

Kentucky Basin (Figure 6). (A livestock unit is equivalent to one horse, one mule, one cattle, five swine, seven sheep, or seven goats.) Moreover, the Tennessee Basin has 14.3 horses and mules per square mile in comparison with 14.1 in the Kentucky Basin. Of this number, Tennessee has 5.8 horses and 8.5 mules, whereas Kentucky has 10 horses and 4.1 mules. That Tennessee has about twice as many mules per square mile as Kentucky but only one-half as many horses per square mile is, apparently, the result of both cultural and natural conditions. Stockmen in the Tennessee Basin have specialized in the breeding of fine mules (draft mules) for a period equally as long as that devoted to horse breeding in Kentucky. Although the breeding of mules is spread rather evenly over the Tennessee Basin, the chief center of concentration is in Maury County around Columbia.

Columbia claims to have the largest "street market" for mules in the world. From sixteen to twenty thousand mules change hands annually. The majority of these sales take place on the streets around or near the Court House. The total volume of this business amounts to approximately two and one-half million dollars each year. The days of heaviest trading are the first Mondays of the eight months from September to April inclusive. The major annual event, however, is held the first Monday in April and is known at present as "Mule Day." Although this celebration has been held annually for about one hundred years, it was first called "Breeders Day," later "Livestock Day," and "Mule Day" since 1935. On this occasion the fine mules of Maury County are brought to Columbia and paraded along the town's chief streets. On the first Monday in April, 1939, this parade was led by hundreds of beautiful girls riding fine mules without saddles. In front of the reviewing stand, on which sat the governor and other leading officials of the state, a mule selected for the occasion was crowned king. The farmers of Maury County insist that the large bone structure and the superiority of their mules are traceable to a type of water, bluegrass, and feed which come from a soil very high in phosphate and lime.

FIGURE 11.—Landscape view in Harrison County showing ridge and valley topography of Eden Shale Belt. Note the surface rock bare of vegetation and the rock fence in the foreground. Between these is a dry creek bed. The small patches of corn and tobacco in the center and right, and wheat in the extreme left reach only about half way up the slope. The upper part with its numerous trees is used for pasture, but one with a relatively low carrying capacity. The road follows near the bottom of the V-shaped valley.

The fact that the Tennessee Basin has more of its land in cultivation helps to explain why more mules are produced in Tennessee, for they are preferred by most farmers in the South for farm work. Memphis, in the southwest corner of the state, is said to be the largest mule market in the world. No doubt the accessibility of this and other near-by markets has greatly stimulated mule production in the Tennessee Basin.

Cattle.—Much land in both basins is utilized for the production of cattle, for they compose about three-fifths of all livestock units on the farms (57 per cent in the Kentucky Basin and 64 per cent in the Tennessee Basin). Per

square mile, they number 42 in the former and 49 in the latter basin—densities considerably above the averages of the two states. The relatively large number of beef cattle reflects many natural advantages including fine bluegrass pastures, a long growing season of eight to nine months, fertile soil which produces a high yield of corn for grain and silage, nearness to the cotton region with its cotton seed meal, and excellent markets at Cincinnati, Louisville, and Nashville. Another important reason is the fitness of the land for a combination of cattle and bluegrass. The carrying capacity of the bluegrass pastures is greater than is needed for all cattle produced in the basins. Consequently, many feeders are shipped in, particularly into the Inner Bluegrass subarea, where they are grazed on the bluegrass pastures for approximately twelve months before they are sold as "grass fat" cattle (Figure 10). On the hill lands of the Eden Shale Belt and on the rougher parts of the Tennessee Basin, beef cattle are far less numerous, poorer in grade, and smaller in size than on the better parts of the basins.

Dairy cattle are more numerous than beef cattle in both basins. This is particularly true in the vicinities of the large urban centers where dairying, with the product sold as milk and butter, has proved to be more profitable than a combination of grazing and tobacco production (Figures 12 and 13). Dairy cattle are more evenly distributed in the Kentucky Basin than are other farm animals. For every 1,000 acres of farm land there are 44 dairy cows in the Outer Bluegrass, 31 in the Inner Bluegrass, and 27 in the Eden Shale Belt. The greater number in the Outer Bluegrass subarea is in accordance with the larger urban centers lying along the Ohio River. The increased interest in dairying is a response of the farmers

FIGURE 12.—Typical landscape scene in Outer Bluegrass showing one of the many fine farmsteads. Note the relative scarcity of shade trees as compared to the Inner Bluegrass subarea shown in Figure 10. This view is in Mason County where dairying is of more than average importance.

to the post-war urbanization movement and has been augmented by the building of creameries in most of the county seat towns. The whole movement, however, has been made possible by the building of hard-surfaced roads and the advent of the motor car.

Swine.—There are about one and one-half times as many swine per square mile in the Tennessee Basin as in the Kentucky Basin (7.3 to 5.2 units per square mile). This dissimilarity is explained by the difference in corn land in the two basins. The Kentucky Basin has a shortage of corn because of its tobacco and bluegrass land-use program. As a result of this program, a large proportion of its hogs is shipped out of the basin as shoats or feeder pigs rather than as fat hogs. Unlike dairy cows, swine are distributed very unequally in the Kentucky Basin. For every 1,000 acres of farm land there are 103 swine in the Inner Bluegrass, 78 in the Outer Bluegrass, and only 23 in the Eden Shale Belt. Compare swine production with corn production (Figure 6). Swine constitute a more important rôle in the livestock set-up in the Tennessee Basin where corn occupies 39 per cent of all the cultivated land. Unlike the

Kentucky Basin, most of these animals are sold as fat hogs rather than as shoats and feeders. It is not uncommon in the Tennessee Basin to see large fields of corn being "hogged down." This method saves the expense of gathering the corn and also that of feeding the hogs.

Sheep.—Sheep fit into the livestock combination of these basins because they are valuable in conserving soil fertility, they require little expensive feed, they eat and destroy weeds and other non-useful plants, and they represent a paying investment which comes in the spring or early summer before crops are ready for market. They rank next to cattle in the Kentucky Basin with 12.2 units per square mile, but are exceeded by horses, mules, cattle, and swine in the Tennessee Basin where the number drops to 5.5 units per square mile. For every 100 acres of farm land there are 420 sheep in the Eden Shale Belt, 373 in the Inner Bluegrass, but only 124 in the Outer Bluegrass. In the hilly Eden Shale Belt, their presence denotes effective use of low priced land not well suited to cropping because of steep slopes and stony soil (Figure 17). On the rich and level land in the Inner Bluegrass sheep are also numerous. In fact, great flocks of sheep may be seen grazing in bluegrass pastures on the highest priced land in the state. Many farmers believe that sheep are more profitable than beef cattle because of the small amount of winter feed they need, the large number of twin lambs they bring, and the dual products of wool and mutton they produce. The hill and knob lands in the Tennessee Basin constitute the chief sheep pastures of the region. Sheep grazing is one of the highest economic uses that can be made of these steep and rocky slopes.

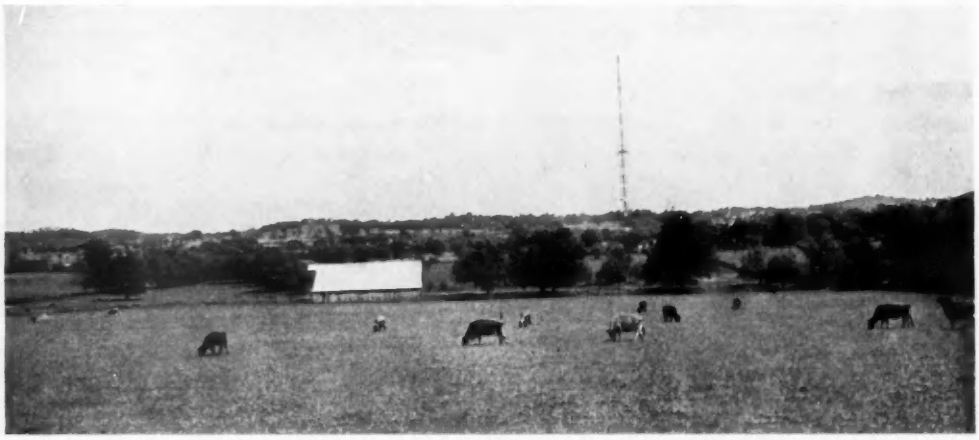

FIGURE 13.—Landscape view in the Tennessee Basin near Nashville. Note distinct contrast between fine level land in foreground and hill and knob land in background. The relatively high percentage of hill and knob land with steep and rocky slopes in the Tennessee Basin helps to explain why the productivity of the land is less than that in the Kentucky Basin. The nearby Nashville market produces a very wholesome effect on the dairy industry of this area. (Courtesy of Dr. A. E. Parkins.)

Goats.—The production and grazing of goats are adjustments of man to types of land on which economic returns are definitely limited. That is, goats are generally relegated to lands which are not well suited for the production of other farm animals. Consequently, goats are conspicuous by their absence in these basins, for there are only nine-tenths of one goat unit per square mile

in the Tennessee Basin and five-tenths of one unit in the Kentucky Basin. Most of these are found on the poor pastures occupying the steep and rocky slopes in the Eden Shale Belt, and similar slopes on the glades, hills, knobs, and ridges in the Tennessee Basin.

are similar in that they are all important route centers, and their wholesale, jobbing, and warehouses are the major collecting and distributing establishments in the basins. A brief description of each shows various ways in which they are dissimilar.

URBAN CENTERS IN BLUEGRASS BASINS OF KENTUCKY AND TENNESSEE

Class	*Kentucky*	*Population*	*Tennessee*	*Population*
First class	Louisville	307,700	Nashville	153,900
	Covington-Newport	135,100		
Second class	Lexington	45,700	Murfreesboro	8,000
	Frankfort	11,600	Columbia	7,900
	Winchester	8,200		
Third class	Danville	6,700	Shelbyville	5,000
	Maysville	6,600	Lebanon	4,700
	Richmond	6,500	Fayetteville	3,800
	Paris	6,200	Pulaski	3,400
	Cynthiana	4,400	Franklin	3,400
	Mt. Sterling	4,300	Gallatin	3,100
	Georgetown	4,200	Lewisburg	3,100
	Harrodsburg	4,000		
	Shelbyville	4,000		
	Lebanon	3,200		
	Nicholasville	3,100		

URBAN LAND

It is the intensive usage of a relatively small amount of land rather than an extensive usage of a large amount that denotes the importance of land utilized for urban purposes. The intensity of usage of the urban land is shown by the fact that 55 per cent of all the people in the Kentucky Basin and 38 per cent of those in the Tennessee Basin live in urban centers (Figure 2). (The term urban center as used in this study means a town with a population of more than 2,500 people. Towns with a population less than 2,500 are considered a part of the rural population.) On the basis of size and function, the urban centers of these basins fall into three main classes: (1) route, trade, and manufactural centers of first magnitude, (2) route and trade centers serving areas larger than counties, and (3) county seat trade centers.

The urban centers of first magnitude

First class urban centers.—Nashville with a population of 154,000 is located on the outside of a bend in the Cumberland River near the northwest margin of the Tennessee Basin. It is strictly regional in function. The location and early growth of the city were greatly favored by the navigable river on which it is located. Its later and more recent growth has been equally favored by the building of railroads and highways which have focused directly on it. The rail and highway patterns with a single focal point in the Tennessee Basin are quite unlike those of the Kentucky Basin with two major and several minor focal points. This focusing of routes has helped Nashville to become an important commercial center for the entire basin. Its wholesale, jobbing, and warehouse establishments collect raw materials from and send manufactured products to all parts of the basin. The raw materials supplied by the fields, forests, and mines have given

FIGURE 14.—View showing two fields but three land uses in Madison County, Outer Bluegrass subarea. The field on the right is being used for pasture just as the one on the left was one year before this picture was made. Note that the land is rolling to hilly and that tobacco is planted on the low bottom land which is more fertile than the upland planted in corn.

rise to a manufacturing industry of no little significance. The flour mills, saw mills, and fertilizer factories are excellent examples of industrial plants that consume raw materials from the basin. Nashville is the state capital and this together with its central location makes it the chief political city of the state. Its several outstanding educational institutions have earned for it the title, "The Athens of the South."

The two large urban centers in the Kentucky Basin are located on the extreme margin of the basin and serve the areas across the Ohio as well as the Bluegrass Basin. The Covington-Newport urban center which is composed of eight towns each with more than 2,500 people has an aggregate of 135,000, and is located at the mouth of the Licking River just across the Ohio River from Cincinnati (Figure 8). Newport, Fort Thomas, Dayton, Belvue, and Clifton are strung along the terrace lands on the east side of the Licking; and Covington, Ludlow, and Elsmere are similarly located on the west side of the Licking. The Covington-Newport center is a major rail and highway center because at the same time the routes focus on it they also focus on Cincinnati just across the river. In addition to these two types of transportation, the Ohio furnishes a third means of assembling and dispersing commodities. With the aid of these superior methods of transportation, this urban center has become dominantly a commercial and manufacturing one. The commercial phase, however, is overshadowed by the manufacturing phase because of the specific types of processing. Heavy manufacturing of a metallurgical type is in the lead. Important in this group are the foundry and machine shops, and factories for making sheet metal and wire specialties. Obviously, the marked importance of this urban center is closely related to its particular location at the mouth of the Licking directly opposite Cincinnati and to its relation to the entire metropolitan area.

Louisville had its origin and early growth at the time when river navigation was of paramount importance. The falls, or rapids, in the Ohio at this point caused it to be a bulk-breaking point. The river cargo, particularly during the dry season, had to be unloaded, carried around the rapids, and reloaded onto the boats. This necessitated much labor and explains the early growth of the town. Later a government canal was dug which permitted boats fully loaded to pass, but even this caused a temporary halt in river traffic. With the start the city got during the period of water transportation, it is only logical that it should become an important rail center during the railroad building epoch. The metropolitan center as it stands today has a little more than 300,000 people. The location of Louisville relative to the White Burley tobacco area together with its good transportation facilities has helped it to become one of the leading centers in the United States for the storing, manufacturing, and

selling of tobacco. The nearness of Louisville to the excellent bluegrass farms in the Lexington vicinity with their fine race horses has helped the city to develop at Churchill Downs, a Derby rich in tradition and unsurpassed in fame even by the one at Epsom Downs in England after which it is modeled.

Second class urban centers.—The second type of land used for urban purposes includes five route and trade centers serving areas larger than counties. These centers are Lexington, Frankfort, and Winchester in the Kentucky Basin, and Murfreesboro and Columbia in the Tennessee Basin. Each of these centers is served by a number of hard-surfaced highways, each is on a main line railroad, and with the exception of Murfreesboro each is a junction for railroads. The focusing of transportation routes on these urban centers has affected them in two ways. First, it has caused them to grow faster than other urban centers with less favorable transportation facilities; and second, it has extended the wholesale and retail trade area of each considerably beyond its county limits. With the exception of Frankfort each of these urban centers serves not only an appreciable part of the basin in which it is located but also a district lying outside the basin. For example, railroads lead from Lexington and Winchester into the coal lands of eastern Kentucky; a branch railroad leads from Columbia to the phosphate, iron ore, and forest lands of the Highland Rim to the southwest; and trunk highways lead from Murfreesboro to the coal and forest lands of the Highland Rim to the East.

Lexington with about 46,000 people is the largest of this group. It is the county seat of Fayette County and is located near the center of the Inner Bluegrass subarea. It is decidedly the most important rail and highway center of the group. All three of the railroads serving the Kentucky Basin have main lines running through Lexington, and seven trunk highways enter it. The city is primarily a trade center, for it draws retail customers from all parts of the Inner Bluegrass and its wholesale trade area extends even farther out. This means a lot to the city when it is

FIGURE 15.—Permanent bluegrass pasture on rocky slope in Cannon County near the eastern margin of Tennessee Basin. Not only are there many large rocks on top of the ground, but the soil, in general, is too shallow to be plowed or to grow crops. Compare the appearance of the land with that shown in Figure 10.

recalled that the purchasing power of the people is extremely high. The city has quite a number of manufacturing plants, most of which utilize as raw materials products from the farms. Milling and refining are the two most important types of manufacturing. The location of the city in the heart of the White Burley tobacco area makes the selling, warehousing, and processing of tobacco the most important activities in the city. Approximately 70,000,000 pounds, or about one-fourth of the country's annual production, are sold in the Lexington market for the enormous sum of ten to eighteen million dollars. Lexington is an important educational center for it is the home of the state university, Transylvania College, Hamilton College, and Sayre College.

Frankfort with about 12,000 people is the next city in size of this group. It is the state capital of Kentucky as well as the county seat of Franklin County. The city, located on a terrace cut by the Kentucky River, stands about 300 feet below the upland and is flanked by limestone cliffs which rise precipitously from the level land on which the city is built. The river is very narrow and easy to bridge at this point. Except for water transportation, Frankfort possesses no more favorable conditions for a city site than the other urban centers in the Inner Bluegrass subarea. In many ways its location is inferior to the surrounding towns. The precipitous bluffs make it hard to reach by rail and highway, and it is not an outstanding rail or highway center even today. The business part of the city and the old state building are located on the east side of the river, whereas the newer part of the town is located on the west side of the river. The growth and development of Frankfort are closely related to the amount of level land on the two terraces flanking the river. With the present population an undue attenuation of form has not resulted, but any material growth in the future will of necessity result in an up or down stream expansion of urban land.

Winchester in the Kentucky Basin and Murfreesboro and Columbia in the Tennessee Basin have a population of about 8,000 each. Each is the county seat of a rich agricultural county, and, therefore, functions primarily as a collecting and distributing point for products produced and consumed on the farm. Owing to the focusing of the rail and highway nets on these towns, they have trade areas which reach considerably beyond the county limits in which they are located. This in turn increases both the quantity and quality of their various commercial establishments. These towns contain beautiful residential sections which have attracted many wealthy farmers when they were ready to retire. The residential function of these towns is further augmented by the State Teachers College and Tennessee College for Women located in Murfreesboro, Kentucky Wesleyan College located in Winchester, and Columbia Military Academy located in Columbia. Significant dissimilar phases of these urban centers include the red cedar products industry of Murfreesboro, the outstanding mule market at Columbia, and the greater importance of Winchester as a railroad junction with four of its six lines leading to the coal lands to the south and east.

Third class urban centers.—The third type of land utilized for urban purposes includes a group of county seat trade centers. Eleven of these trade centers lie in the Kentucky Basin and seven lie in the Tennessee Basin. They range in population between 3,100 and 6,700. Each of these is the county seat of a

Figure 16.—Woodvale farm in Bourbon County. This farm is one of the beautiful "show places" in the Inner Bluegrass subarea where tradition has inspired man to produce better and faster horses.

good agricultural county, each has railroad service, and with the exception of Shelbyville, Tennessee, each is served by a through line. Seven of those in Kentucky and two of those in Tennessee are railroad junctions. With the exception of Franklin, each is located at the crossing of two or more hard-surfaced highways. As might be expected, these towns, surrounded with rich farm land and served by adequate transportation facilities, are primarily agricultural trade centers. The operators of the grain mills, warehouses, and stock yards in these towns buy from the farmers grain, tobacco, cotton, livestock, poultry and eggs, and other farm products; and the retail and wholesale establishments in turn supply the farmers with groceries, articles of clothing, fertilizers, farm implements, automobiles, and other manufactured goods. Not one of the eleven Kentucky towns lies in the Eden Shale Belt with its relatively poor soil. Richmond, Shelbyville, Mount Sterling, and Lebanon are located in the Outer Bluegrass subarea; Danville, Paris, Cynthiana, Georgetown, Harrodsburg, and Nicholasville lie in the Inner Bluegrass; and Maysville is a river town on the Ohio.

Centre College and Kentucky School for the Deaf located in Danville, Georgetown College located in Georgetown, Eastern Kentucky State Teachers College located in Richmond, Cumberland University located in Lebanon, Tennessee, and Martin College located in Pulaski have contributed to the growth of these urban centers. The location of Maysville on the Ohio River at the extreme eastern margin of the Kentucky Basin has stimulated industrial development to a higher degree than exists in the towns in the Inner and Outer Bluegrass subareas where river facilities are not available. The town has a very unique pattern for it is only a few hundred feet wide but is three or four miles long. It is built on a narrow terrace which lies about 300 feet below the upland flanking the river gorge. If the land suitable for urban use was not so limited in amount and attenuated in form, the town, in all probability, would be considerably larger than it is at present.

Land Utilized for Transportation Purposes

Land utilized for transportation purposes forms a very definite part of a land utilization study. Although the amount of such land may not form a high ratio of the total, it, like urban land, is very intensely utilized. Land for this purpose includes that used for highway, rail, and water transportation.

River transportation.—Water transportation in the Bluegrass basins has been limited to the Ohio, Kentucky, and Licking in the Kentucky Basin and to the Cumberland in the Tennessee Basin. The Licking is used little or none at the present time. Early improvements for river navigation were made by private interests. A little later the states assumed the responsibility of river improvements, and in 1879 the federal government took over the control and improvement of inland navigation. Locks were built on the Ohio at Louisville to remedy the trouble caused there by the rapids in the river. Fourteen locks were built on the Kentucky River with an average lift of about sixteen feet in order to make the river navigable for a distance of 260 miles above its mouth. With a limited amount of improvement the Cumberland was made navigable throughout the entire part of its course lying in the Bluegrass Basin. Prior to about 1840, these streams were the principal means for transporting any sort of heavy freight. Maysville, Covington-Newport, and Louisville on the Ohio; Frankfort on the Kentucky; and Nashville on the Cumberland were the concentration points for water cargo. Coal, logs and lumber, and iron and steel products are the chief commodities transported on these streams at present. Most of the freight is carried on flat-bottom barges pushed by tow boats. In addition to the freight handled by barges, packet boats do a good business on the Ohio.

Railroads.—Although railroad development began in the Bluegrass basins just prior to 1840, it was the twenty-five year period following the close of the Civil War in which most of the railroad mileage was built. Each basin is served at present by three rail systems. Serving the Kentucky Basin are the Louisville and Nashville lines with 60 per cent of the mileage, the Southern lines with 25 per cent of the mileage, and the Chesapeake and Ohio lines with 15 per cent of the mileage. Serving the Tennessee Basin are the Louisville and Nashville, the Tennessee Central, and the Nashville, Chattanooga, and St. Louis railroads. All the towns or cities in both basins with a population of 2,500 or more are served by one or more of these roads. It is those cities, however, which are located where two or

FIGURE 17.—A large flock of sheep grazing on the steep and rocky slope land of the Eden Shale Belt (northern part of Scott County). The utilization of this type of land for sheep pasturage denotes an effective use of low priced land not desirable for farm crops

more lines intersect, such as Louisville and Nashville, that have benefited most as a result of rail transportation.

Highways.—Since the coming of the first white settlers, the basins have had roads, but it has been during the last two or three decades only that this use of land has played so prominent a part in the lives and activities of the people. At present, virtually every county seat town is connected with the county seats in all the adjoining counties by a hard-surfaced highway. A great deal more land is used for roads now than twenty years ago, not only because of the increased mileage but also because the rights of way are so much wider. Every mile of right of way 70 feet wide contains approximately nine acres of land. Practically all of the mileage of the federal and state highways is hard-surfaced with concrete or asphalt. The county roads that are not hard-surfaced are generally graded and graveled.

The three types of transportation are highly competitive, for just as the railroads took from the river transports a large part of their freight and passenger business during the three decades following the Civil War, so has the motor vehicle taken from the railroads since 1920 a large percentage of their business.

NOTE.—The data and ratios used in this study, unless otherwise stated, are taken or calculated from the Fifteenth Census of the United States for 1930 showing statistics on population by counties. The statistics for agriculture are taken from the same source but are for the year 1935. The data taken or calculated include 59 items bearing on population and land utilization for each of the 55 counties lying in the two basins. The field work in the Kentucky Basin was done in August and September of 1938. Field work done by the author in the Tennessee Basin dates back over a period of more than ten years.

BOOK REVIEWS

ELY, RICHARD T., AND WEHRWEIN, GEORGE S. *Land Economics.* xiii and 512 pages. Published by The Macmillan Company, New York, 1940. Price $4.00.

For many years Richard T. Ely has held a place of honor and authority among the land economists of America. For more than twenty years his place of leadership has been secure, both in the teaching field and in the field of investigation and research. He has been in the forefront of tillers of this particular field. Through the decades of his leadership, his field has expanded and become increasingly important, until today the great broad problems of land utilization and conservation engage the attention of the best minds of the whole nation. In this broader, expanded field, the senior author still holds leading rank, and the junior author has attained to a position of active service comparable with that of his mentor.

Few books are so authoritative in their field as is Ely and Wehrwein's "Land Economics." Only decades of experience and experiment as have accrued to the content of this book from the work of the authors, can produce such dominance in any single field. The University of Wisconsin has gained from its experts on land utilization an eminence in the field second to none, and has rendered a service to our country that is as great as any service any state university has been able to yield.

As long ago as 1924 the senior author and Edward W. Morehouse in joint authorship gave to America "Elements of Land Economics," issued from the same press as comes this newest volume by the same senior author and George S. Wehrwein. It was from that earlier book and under the instruction of a Wisconsin graduate that the reviewer learned the principles of land economics; accordingly a bit of partisanship and prejudice in favor of the book may perhaps be excused.

But all prejudices ignored, "Land Economics" is a strikingly good book. It includes the essential material for foundation in the broad field of land utilization. Adequate consideration of the element of population, the element of land, the element of industry, the element of urbanization and the elements of trade, taxes, tenure, and the multitude of other influences affecting the use of land, marks the entire text.

Probably the best way of summarizing the contents of the book is to list the chapters: I. Land Population; II, III, and IV. Land as Nature, Space, and Property, respectively; V. The Economics of Land Utilization; VI. Agricultural Land; VII. Agricultural Land Tenure and Soil Conservation; VIII. The Utilization of the Arid Lands; IX. Forest Land; X. The Environment and Recreational Land; XI. Water Resources; XII. Mineral and Power Resources; XIII. Urbanization and Urban Land; XIV. Conservation and Social Control Over Land, A Summary; a bibliography and index complete the more than five hundred pages of the book. Unity and uniformity of treatment characterize the book. The text reads clear and interesting. Nothing irrelevant or inconsequential is included. Everything required for an understanding and apprehension of the field of land utilization is included. Not only is it valuable as a text and reference book, but it is engrossing reading for the subject matter itself; the layman would benefit by incorporating the knowledge of its material into his qualifications for citizenship. It lends itself well to collegiate classes and high school reference. It is the kind of book that attracts by its uniform high quality rather than by any sensational or novel approach, organization, or subject matter.

Like all Macmillan books, it is bound exceptionally well, its paper is superior, its type clear and restful. The thousands of students in our colleges of agriculture and commerce, and for that matter in our liberal arts colleges as well, can take no courses more valuable to their training for citizenship than one in land economics or land utilization, based upon this very excellent book by Ely and Wehrwein.

W. E. E.

CARTER, WILLIAM HARRISON JR. and DODGE, RICHARD ELWOOD. *Economic Geography,* xi and 564 pages. Published by Doubleday, Doran & Company, Inc., New York, 1939. Price $3.75.

KLIMM, LESTER E., STARKEY, OTIS P., and HALL, NORMAN F. *Introductory Economic Geography,* second edition. ix and 501 pages. Published by Harcourt, Brace and Company, New York, 1940. Price $4.25.

Among recent textbooks, two in economic geography deserve particular mention in this magazine: Carter and Dodge's "Economic Geography," and the revision of Klimm, Starkey, and Hall's "Introductory Economic Geography." Both of them will be before the public for use at the beginning of the next college semester and undoubtedly both of them will engage considerable portions of the trade for the ensuing year. "Economic Geography," by Carter and Dodge, is in the old, conventional orthodox tradition, about a third of the book being devoted to the physical and economic factors affecting

production, and the remaining two-thirds of the book treating the major groups of commodities in world trade and industry. "Introductory Economic Geography," by Klimm, Starkey, and Hall, represents an innovation in the format, visual presentation, and organization of material, having about one-fifth the space devoted to physical environment; a little more than a fifth of the space to foods, raw materials, and fuels; about one-tenth of the space to commerce and manufacturing; and a little over two-fifths of the space, but not quite one-half, to regional economic geography.

After all, provided the material presented is adequate in scope and relevant in purpose, the organization of the material is not so vitally important, its significance depending chiefly upon the purpose to which the material is to be put. For a liberal arts college, as so many of the collegiate institutions of the United States still are either wholly or in part, Carter and Dodge's sound and carefully prepared book seems quite satisfactory. For professionalized schools of industry and commerce, like the Wharton School of the University of Pennsylvania, schools of business, and departments of commerce and industry in the larger state and other institutions, Klimm, Starkey, and Hall's exhaustive and relatively specialized book, seems most suitable. Whether or not the regional approach so strongly emphasized in the latter volume is justified by the use to which it is put may be questioned by some of the more active economic geographers, but that it does have certain distinct advantages is obvious.

The revision of Klimm, Starkey, and Hall's "Economic Geography," has eliminated most of the errors, the most unsatisfactory maps, and some of the discrepancies, to which objections were raised in the earlier edition. The maps particularly have been substantially improved, the illustrations seem clearer and more pertinent, and on the whole the volume is much improved over the first imprint. Though the approach to the subject is not so orthodox as is most of the material presented in other economic geographies recently issued, it is thoroughly sound, and conservative enough to make any criticism on that score rather captious. Any student interested in the field of geography or in the geographic factors affecting man's activities will find practically everything necessary and desirable within its pages. The format, though rather unusual, leads to no inconvenience or difficulty in use: in fact, the larger size of the page enables the authors to present their maps and illustrations on a scale large enough to be clearly and easily understood. Very few of the pages are without some form of map, chart, or half-tone photograph, so that the monotony of solid pages of text is nearly everywhere broken, a desirable and advantageous feature when so much factual material is crowded together.

Carter and Dodge's book is similarly easy to read and easy to handle. The length of the lines on a page, and the size of the page, do not constitute any obstacles to easy and comfortable reading. Though not so richly illustrated as some of the recent books in economic geography it does not lack adequate or satisfactory visual illustration. The maps are fewer, and in general simpler, but they bring out the point for which they were made. The charts and graphs similarly serve to supplement the text. The paper is whiter, and perhaps somewhat glossier than that in Klimm, Starkey, and Hall's book, but there is no glare from it. There is no change in character of paper between the text pages and the illustration pages, as there is in Klimm, Starkey, and Hall's book.

On the whole, both these texts may be approved justifiably for collegiate courses. They represent different points of view, different approaches, but both present their material adequately and satisfactorily. Both books will find ardent supporters.

W. E. E.

LANDON, CHARLES E. *Industrial Geography.* xvi and 811 pp. Published by Prentice-Hall, Inc., New York. Price $4.00.

When an economist writes a geography the result is likely to fall into the same category of achievement as when a cobbler cuts a steak, a tanner weaves a carpet, a lawyer pulls a tooth or performs an appendectomy, or a railway engineer runs a river steamer. Doctor Landon's book might better have been entitled "Industrial Economics" for then its relative dearth of geographic fact and geographic relationships would not have seemed so obvious or so subject to criticism. For use in a class in economics even, it scarcely furnishes a minimum of basic geography, certainly not an adequacy. It is too much "like a 'Hamlet' with Hamlet left out"

For a textbook in geography it suffers from compilation and inclusion of too much material from government reports and state bureaus; from undue emphasis upon technological processes rather than geographical causes, effects, and relationships; from failure in places to evaluate effective factors carefully enough to distinguish critical or significant geographic influences; from inexplicable omissions, as for example, no mention of Guadalajara a ranking city of Mexico with important industries in shoes, hosiery, cotton goods, pottery, glass, and beverages, though such centers as Torreon, Chihuahua, and Aguascalientes are mentioned; from many apparent misstatements, some minor, some major, such as placing the center of the bulb industry of Netherlands in Haarlem on land once covered by a lake of the same name, whereas bulbs, according to competent authorities, are not adapted to the heavy clay soils of the polders,

but to the sand-covered peat farther west on the inner dunes zone.

It must not be assumed from this rather critical introduction that the book has little, or no, merit or value. On the contrary, the book measures up well to other work that Doctor Landon has done before, even though it falls short in many ways as a geography. There is a wealth and variety of factual material that few such books possess, and much careful and sound interpretation and description of noteworthy interest to the undergraduate student for whom the book is written, and likewise for the lay reader and business man not primarily concerned with academic problems or educational programs. It is doubtful, however, whether or not it lends itself to one semester's course even for advanced undergraduates; it would better occupy two semesters, for which its organization of material apparently lends its use. The book is mechanically well done, and the paper and type used are quite satisfactory.

As a general book for economics majors it may prove of merit; none of them is likely to contract a severe case of geography from the material it presents.

W. E. E.

GUSTAFSON, A. F., RIES, H., GUISE, C. H., and HAMILTON, W. J., JR. *Conservation in the United States.* xi and 445 pages. Published by Comstock Publishing Company, Inc., Cornell Heights, Ithaca, New York, 1940. Price $3.00.

Interest in conservation is perhaps expressed by the increasing number of books and magazine articles issuing on the subject from the presses of the country. The last three or four years have been marked by an unusually large number of contributions to the literature of the subject, some of which have not been unusually profound or unduly critical. There has been a great deal of emotion, a great deal of confusion of thought, and worse, a great deal of insidious propaganda woven into the texture of conservation research and literature; in fact, so much emphasis has been placed upon the necessity for conservation that the cause of wise and conservative utilization has suffered, with the result that the public is beginning to be somewhat dubious, not to say suspicious, regarding the validity and the relative importance of some of the arguments presented.

This volume under review by four Cornell authorities in their respective fields, reverts to the conservativeness and good judgment displayed by the first significant volume in the field of conservation, Charles Richard Van Hise's "The Conservation of Natural Resources in the United States," which appeared thirty years ago. There has not been since that time a better book in the field of conservation, one that so convincingly argued the need of conservation and the benefits to be derived from a reasonable and well considered policy of safeguarding the nation's resources. For wellnigh twenty years that excellent pioneer in the field monopolized the subject, and established the fundamental principles of state and private conservation. Then began to appear, first a more dilettante treatment of the subject, and then a series of publications suspiciously savoring of propaganda, some of them worthy, some of them indifferent, some of them inexcusably bad, though all of them probably well intentioned.

Under the able editorship of the late Almon Parkins and J. R. Whitaker, the National Council of Geography Teachers issued in 1936 a volume on conservation of which the chapters were prepared by specialized authorities in the several phases of the field, and though it made a valuable contribution to the literature on conservation, it suffered from the great diversity of points of view and methods of approach as well as heterogeneity in character and composition of material. The book was widely used, however, and is still a valuable addition to the subject despite the fact that it does not lend itself satisfactorily to undergraduate teaching.

"Conservation in the United States," by the four members of the faculty of Cornell University, is not only a compact and unbiased statement of the reasons and needs for conservation, the technique of conservation methods, and the results to be obtained by the sound policy of conservation, but it is also a book that lends itself admirably to academic courses. The undergraduate student using this book will probably receive a better impression of the subject, a more balanced knowledge of its needs and methods, and a more satisfactory appreciation of the diversity and universality of the problems of conservation. The four authors have apparently conferred intimately on the organization of the material which they present, to make the book a unified, comprehensive, and authoritative treatise throughout, distinguished by its rationality and its unity.

The book is divided into four major parts. Part I deals with the conservation of soil and water resources; Part II, the conservation of forests, parks, and grazing lands; Part III, the conservation of wildlife; and Part IV, the conservation of mineral resources. A well selected bibliography of selections for supplementary reading is appended; the index is adequate, the paper is superior, and the type clear and legible. It goes without further saying that this book embraces the kind of material that the collegiate undergraduate can use advantageously because it is not too detailed, not to biased, not too expansive for his ready mastery. Certainly the teachers of conservation both in college and in the high schools will welcome this book as an answer to their prayers for a text really adapted

to their needs. The book should command the attention of all teachers of conservation; it may perhaps lack adequacy of detail and treatment for the cordial approval of the specialist, even though he may value it as a trustworthy summary.

W. E. E.

EKVALL, ROBERT B. *Cultural Relations on the Kansu-Tibetan Border.* xvi and 87 pages. Published by The University of Chicago Press, Chicago, 1939.

Though essentially anthropological, this fascinating account of a region about which so little is known has many geographic implications that are sure to prove of value to the professional geographer, and the teaching of geography. The description of the Kansu-Tibetan border, though relatively brief, helps picture that remote and inaccessible region to which so few Europeans or Americans have ever attained.

The author has the advantage of a rather protracted visit to the region and a prolonged stay within its confines. Consequently, his description of the marginal conditions in the region, of the transitional character of the physical and cultural attributes, and of the distinctive activities in which the folk of that transitional belt engage, bears proof of authenticity as well as the stamp of scholarly research. It is a book well worth adding to the library on China and its geography.

W. E. E.

LATTIMORE, OWEN. *Inner Asian Frontiers of China.* xxiii and 585 pages. Published by American Geographical Society, New York, 1940. Price $4.00.

PRICE, A. GRENFELL. *White Settlers in the Tropics.* xiii and 311 pages. Published by American Geographical Society, New York, 1939.

The complicated political and military pattern of affairs in and about China, a sort of triangular problem with Japan at one angle, China at another, and Russia at the third, makes this new book by Owen Lattimore peculiarly significant at the present time. All three countries are unfortunately too little understood in America. The Orient is so complicated and vast a region that with all the knowledge the peoples of the other parts of the world must acquire about their neighbors it becomes an almost impossible task for them to master the intricacies of the relationships of those three countries that make the Orient a cockpit of intrigue, and politics, and internecine war.

It is to the everlasting credit of the American Geographical Society that it annually undertakes to acquaint its membership, and the reading public as well, with some land or feature of the earth's surface which might not otherwise be brought to general attention. In the course of the years the shelf of books thus issued by the American Geographical Society has grown to appreciable proportions. No geographer is willing, or can afford, to be without the very excellent series of books of which the volume under discussion "Inner Asian Frontiers of China" constitutes the 21st in the research series. Like all others of the series, it is excellently bound and excellently printed on clear white paper in a most legible type. The Society deserves all the gratitude and appreciation that accrues to it from such a notable project in the service of geographic knowledge.

The author is well known as the Director of the Walter Hines Page School of International Relations at Johns Hopkins, and as the editor of *Pacific Affairs*. He is fully qualified to write authoritatively upon the subject that he has chosen, not only because of his acquaintance with the literature on the Orient, but because he has traveled throughout the region about which he has undertaken to write. Needless to say, he has done a fine piece of work and made a contribution that will remain for many decades one of the most valuable in the field. It is a rather ambitious book, running to the length of almost 600 pages; set in relatively small though perfectly legible type, it embraces even more material than its pages would indicate.

"White Settlers in the Tropics" is another of the publications of the American Geographical Society in the Special Publication Series, of which it forms the 23rd item of issue. A. Grenfell Price, the author, is Master of St. Mark's College, University of Adelaide, Australia. He has written rather extensively on subjects relating to the continent of his birth, and residence throughout most of his years. He has carried on research in Panama, Costa Rica, the West Indies, the United States, and Europe, research that would have qualified him to write the book without the personal familiarity with the Australian tropics which adds so much authenticity and so much trustworthiness to every statement and deduction he makes.

The book is divided into three parts, as follows: Part I. Nature and History of the Problem of White Settlement in the Tropics; Part II. Some White Settlements in the Tropics —Regional Studies; Part III. Some Factors Governing White Settlement in the Tropics. The first is relatively small and condensed; the second is four times the length of the first; and the third is just about the length of the first and second together.

Both these books "Inner Asian Frontiers of China" and "White Settlers in the Tropics," should appeal to the layman as well as to the college student and the college professor, since both of them deal with subjects of international interest all too little known and understood by

the rank and file. Both these books form valuable additions to the long list that the American Geographical Society has already issued with so much benefit to the geographical profession and to the world.

W. E. E.

WADHAM, S. M., AND WOOD, G. L. *Land Utilization in Australia.* xix and 360 pages. Published by Melbourne University Press, in association with Oxford University Press, 1939.

In the last decade a number of excellent books dealing with life in Australia have been made available from the colleges and universities of that antipodal continent, until today the rest of the world has no excuse for not being as well informed about the industries and activities of the Australian folk as those of any other land. "Land Utilization in Australia" is one of the latest of such books to yield an insight into the history and character of land utilization in Australia. Though Australia is larger in area than the United States of America, it does not possess proportionally large and varied resources. The continent is sparsely populated and the potential productive capacity of its territory has not yet been precisely appraised. It is such a book as this that lays the foundation for a well-considered knowledge of the possibilities for developing so great an area in the most satisfactory and productive way.

Despite the immensity of their task in compiling the material for this book, evaluating its relative significance, and organizing it into a body of fact that could be presented clearly and consistently, the authors have achieved a remarkably valuable book. They approached the subject first from the historical point of view, surveying the progress of settlement and development of industry from the beginning of the continent to the present time. This done, they considered thoroughly the natural factors controlling use of land. With these two matters adequately treated, they embarked first upon the study of the wool industry and its place in the Australian economy, and treated it exhaustively. Afterward they treat the wheat industry, the dairying industry, the meat industry, the sugar industry, the fruit industry, and minor crops. They devote one chapter to irrigation, one to forestry, one to land utilization and settlement, and one to the effects of world economic trends upon land use in Australia. By this treatment they are able to present an authoritative and highly satisfactory account of the present situation in Australia as regards the use of the land.

The relationship of American industry and land utilization to those of Australia is well understood by all American economic geographers. There are many similar developments in Australia and the United States, in the way of land use, land tenure, and land problems; for whereas the American problems are north temperate, and those of Australia south temperate, they have much in common because of their somewhat similar latitudes. America is fortunate in lying near the great centers of world population abroad, and having a high density of folk within its own borders; its markets are thus assured it. On the other hand, Australia lies remote from the great markets of the world, and its own market is relatively small.

At the time this review is written the problems arising from the unexpected course of the world war involve the United States almost as seriously as they do the British Commonwealth and Australia. What the outcome is to be it is impossible to say at the time—the unexpected is likely to happen.

W. E. E.